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PHILOSOPHICAL

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OF THE

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OF

LONDON.

FOR THE YEAR MDCCXCIV.

PART I.

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SOLD BY PETER ELMSLY,
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MDCCXCIV.

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OF

THE ROYAL SOCIETY,

FOR THE YEAR 1795.

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THE Committee appointed by the *Royal Society* to direct the publication of the *Philosophical Transactions*, take this opportunity to acquaint the Public, that it fully appears, as well from the council-books and journals of the Society, as from repeated declarations which have been made in several former *Transactions*, that the printing of them was always, from time to time, the single act of the respective Secretaries, till the Forty-seventh Volume: the Society, as a Body, never interesting themselves any further in their publication, than by occasionally recommending the revival of them to some of their Secretaries, when, from the particular circumstances of their affairs, the *Transactions* had happened for any length of time to be intermitted. And this seems principally to have been done with a view to satisfy the Public, that their usual meetings were then continued, for the improvement of knowledge, and benefit of mankind, the great ends of their first institution by the Royal Charters, and which they have ever since steadily pursued.

But the Society being of late years greatly enlarged, and their communications more numerous, it was thought advisable, that a Committee of their members should be appointed to reconsider the papers read before them, and select out of them such as they should judge most proper for publication in the future *Transactions*; which was accordingly done upon the 26th of March, 1752. And the grounds

of their choice are, and will continue to be, the importance and singularity of the subjects, or the advantageous manner of treating them; without pretending to answer for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgment of their respective authors.

It is likewise necessary on this occasion to remark, that it is an established rule of the Society, to which they will always adhere, never to give their opinion, as a Body, upon any subject, either of Nature or Art, that comes before them. And therefore the thanks, which are frequently proposed from the Chair to be given to the authors of such papers as are read at their accustomed meetings, or to the persons through whose hands they receive them, are to be considered in no other light than as a matter of civility, in return for the respect shewn to the Society by those communications. The like also is to be said with regard to the several projects, inventions, and curiosities of various kinds, which are often exhibited to the Society; the authors whereof, or those who exhibit them, frequently take the liberty to report, and even to certify in the public news-papers, that they have met with the highest applause and approbation. And therefore it is hoped, that no regard will hereafter be paid to such reports, and public notices; which in some instances have been too lightly credited, to the dishonour of the Society.

Jos: Banks

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Meteorological Journal kept at the Apartments of the Royal Society, by Order of the President and Council.

ERRATA.

Page 14, line 17, *for* XY, *read* XI.
Page 151, line 4, *for* remaining semiarc, *read* remaining part of the semiarc.
Page 153, note, line 6 from the bottom, *for* 91, *read* 87.
Ibid. note, line 4 from the bottom, *for* 5, *read* 9.
Page 167, line 14, *for* so adjusted, *read* adjusted so.

PHILOSOPHICAL TRANSACTIONS.

I. *An Account of the Discovery of a Comet. In a Letter from Miss* Caroline Herschel, *to* Joseph Planta, *Esq. Sec. R. S.*

Read November 7, 1793.

SIR,

LAST night I discovered a comet near 1st (δ) Ophiuchi, but clouds covering the part of the heavens where it was, its place could not be obtained.

My brother has just now (7 o'clock) determined its situation, as follows.

The comet precedes the 1st (δ) Ophiuchi 6′ 34″ in time, and is 1° 25′ more north than that star.

I remain, Sir, &c.

CAR. HERSCHEL.

Slough,
Tuesday, Oct. 8, 1793.

II. *Account of a new Pendulum.* *By* George Fordyce, *M. D. F. R. S.; being the* Bakerian *Lecture.*

Read November 7, 1793.

Let AB and CD be two rods of any solid of the same species, and of a simple or uniform texture. Let these two rods be exactly of the same length; let them be connected at the top with a rod BC, which is perfectly inflexible, let the angles ABC, and DCB, be both right angles, so that AB and DC shall be parallel to each other, and in the same plane; let the rod AB be fixed at the point A, and perpendicular to the horizon: then the rod CD shall likewise be perpendicular to it, excepting for the curvature of the earth between B and C, which in a foot or two may be considered as nothing: let the rod CD be loose at the end D, so as to be capable of rising up or falling down; in this case, if heat be applied equally to both rods, so as to expand them both, and lengthen them, the rod AB will raise up the rod BC, and lift up the rod DC; but the rod DC being equally lengthened by heat with the rod BA, the point D will be brought downwards by the lengthening of the rod DC, as much as the point C is raised by the lengthening of the rod AB by the heat. In consequence, the rod DC will have its end D in a line exactly parallel to the horizon, and cutting the end of the rod AB at A, as it did before the heat was applied; and the same thing will be true if the

rods AB, DC, be shortened by exposure to cold; so that in all cases of heat or cold the end of the rod CD at D, and the end of the rod BA at A, shall be in a line parallel to the horizon.

Take a point E near any part of the rod CD, and let that point E be connected with the point A, where the end A of the rod AB is fixed, and let the matter which unites them be perfectly inflexible, and incapable of being altered by heat; then, I say, that the part of the rod CD, intercepted at the point E, and forming ED, will always be of the same length whether the temperature of heat is greater or less. For supposing a point F be taken near the rod AB, and of the same perpendicular height with E, so that a line drawn from E to F shall be parallel to the horizon; if the part of the rod AB, opposite to F, should rise up in consequence of being expanded by heat above F, it will carry up the point of the rod DC, which was opposite to E, to an equal height with itself, and therefore would cut off from the length of that part of the rod which was formerly opposite to E, a length equal to that which was added to what was formerly ED, by the heat. Therefore the point opposite to E, in the rod DC, will form ED, which will always continue of the same length, if the heat be increased; and by similar reasoning, it will likewise continue of the same length if the part of the rod AB AF is shortened by cold; therefore the part of the rod DC cut off by the point E, so as to form ED, will always be of an equal length, and the point D will always be of an equal height.

At the point E let there be an apparatus which will render that part of the rod DC which is opposite to the point E flexible, whatever part of it shall be opposite to the point E. Then the part of the rod DC, cut off at the point E, and form-

ing DE, may become a pendulum. Thus we shall procure a pendulum of the same length, whatever be the degree of heat.

Let the rod AB and the rod DC be of different species of matter, so that the rod AB shall be lengthened by being heated to the same degree, more than the rod DC; then, if they be both of the same length, heat would carry up the end of the rod CD, at D, higher than the fixed point A; but if a part be cut off from AB at G, so that the whole of the expansion of the remaining part GB, shall be equal to the whole of the expansion of the whole rod DC, and that in every increase of heat, then the same thing would happen; and the part of the rod DC, cut off by the apparatus at E, would always remain of the same length. If, therefore, it is wished to render DE always equal in length, the fixed point A must be brought nearer to B, so as to shorten the rod AB, that is at G, so that the whole of the expansion of GB by heat, shall be equal to the whole of the expansion of DC by the same degree of heat.

Hitherto I have supposed that the substance which connected the points A and E was incapable of being expanded or contracted by heat: but no such substance is to be found.

I shall now suppose that the substance which connects the points A and E is capable of being expanded by heat. If it was capable of expansion equal to the matter of which the rods AB and CD consist, then it is evident that no advantage could be gained so as to render the part of the rod CD opposite to the point E down to D always equal. But it is clear that the expansion of AE, supposing the point A a fixed one, would carry the point E higher up towards C, if the heat was greater, so that ED would by this means be rendered longer; and the contraction of AE, when exposed to a greater

degree of cold, would bring down the point E so as to render ED shorter, just as much as the expansion of AB would raise up the rod ED, or as its contraction lower it. But if the materials connecting the points A and E were less expansile and contractile by heat and cold, than the matter of the rods AB and CD, then upon the whole expanding, although the point E would be raised higher towards C, yet it would not be raised so high as the expansion of AB would raise the point C, and the whole rod CD. The same is true if the whole of them contract, but in an opposite direction. That is to say, the point E would not descend so far towards D, as the point C would descend towards D, and with it the whole rod CD; by this means, although the part ED would not be always equal, yet it will be much more equal than if the point C were a fixed point, and not capable of being affected with the contraction or expansion of the rod AB.

If then the part of the rod CD, from opposite to the point E to D was a pendulum, it would not be always of the same length, but it would be more nearly so than a simple pendulum made of the same materials of which the rod CD consists; and it would be nearly of the same length as if the pendulum had been made of the materials which connect A and E.

In order then to render ED always of an equal length, some other principle must be employed. Now let BA and CD consist of the same materials; and the matter connecting A and E consist of a substance that expands by heat, and contracts by cold, less than the materials of which AB and CD are formed; if the rod AB be brought down to H, and the fixed point be at H, and the points HE be connected together by the same materials which formerly connected the points AE

in the rod EH, take a point K, equal in height with the points A D, and in the line AD which is parallel to the horizon, as it has already been taken in the construction; then the rod AH shall expand, upon being heated, in perpendicular height more than the rod HK, and therefore the expansion of AH shall carry the point B, and in consequence the point C, higher than the expansion of the rod HK shall carry the point E; but if the expansion of the rod AH be as great as the expansion of the whole rod HE, then the point C will be carried as much higher than the point E, as the point E is carried higher than it was before the heat was applied, and therefore the point E shall be at as great a distance from the point C, as it would have been if the materials connecting AE had been incapable of being altered by heat: and therefore if ED be a pendulum, it will be rendered of the same length. If then the rods AB, and CD, be of the same materials, and the substance connecting A and E is capable of expanding and contracting less by heat than the matter of the rods AB and CD, then, by adding to the rod AB, a part AH, under the circumstances already described, and making the fixed point at H, we can obtain a pendulum always of equal length; or if the materials of which the rod AB consists be capable of being expanded by heat as much as the materials of which CD consists, together with the expansion of the materials that connect A and E, in that case likewise the point C shall be carried as much higher than the point E, as it would be when they are expanded by heat, as if the materials connecting A and E had not been affected by heat at all. Or, lastly, if we take a rod GB, of materials which expand much more than the expansion of the matter of the rod CD, and the connecting matter

of the rod EG by heat, then likewise upon the rod GB expanding, it will carry the point B, and consequently the point C, as much higher than the point E, as it would have been if the materials connecting G and E had been incapable of being expanded by heat, and therefore ED will always continue of the same length. The same reasoning will hold in cases of contraction from cold.

Therefore, if materials be employed in the rod GB, which contract considerably more than those which compose the rod CD, then the fixed point G is to be taken at a distance from B, in an inverse ratio to the inferior expansile power of the materials of which the rod CD consists, and in a direct ratio of the expansile power of the materials which connect E and G. That is, supposing that it was taken in the inverse ratio of the inferior expansile power of CD, then it would be at G; but to counteract the expansile power of the materials GE, it must be somewhat lower at I.

If then the proportion of the expansion of the materials of the rod AB, or GB, the rod CD and the materials which connected AE or GE were known, and the length of a pendulum swinging any proportion of time, in that case the distance and perpendicular height between GE and IE might be taken at once, and a pendulum might be always made which would always be of the same length, therefore swing equal arches in equal times. But these not being perfectly known, and it being extremely difficult, if not impossible, to measure off length perfectly, it is necessary to have the power of varying the distances and perpendicular height between I and E, A and E, or H and E, so that it may be found from trial whether these fixed points I, A, or H, be properly taken. For if, on construct-

ing a pendulum on these principles, either of the fixed points, according to the circumstances, I A or H be placed too high or too low, then the pendulum will vary in its length, and of consequence swing different times in different degrees of heat.

That is to say, suppose the case be taken where the rod BG is made of materials which expand more than CD, if instead of rendering I the fixed point, it is made G, nearer to B, then the point C will not be raised sufficiently above the point E, the pendulum will become longer by heat, and make fewer vibrations in a given time. But if the fixed point in this case be brought lower than I, to the point L, then the point C will be raised higher when the whole is expanded by heat from the point E, ED will be rendered shorter, more vibrations will be performed in a given time, and *e contra*. Therefore if there be a power in the apparatus of altering the fixed point I, if found too high or too low by experiment, we shall be able to find out a true point, and make an adjustment accordingly. That is, if heat occasions a pendulum to make fewer vibrations, the fixed point is too high; if, on the contrary, it makes too many vibrations, then the fixed point will be too low.

I come now to show how these principles may be applied in structure.

As it is more convenient in practice to have the fixed point higher than A, which is equal in height to D the bottom of the pendulum, a substance should be chosen for the rod AB which expands and contracts more by heat and cold than the matter of which the rod CD consists, so that the fixed point should be at G, if the materials connecting A and E were incapable of being expanded or contracted by heat or cold:

but if their expansion and contraction is to be compensated for, the fixed point will be at I, as has already been shewn.

If the expansion and contraction of the rod IB by heat and cold, in proportion to the expansion and contraction of CD, were known, and the expansion and contraction in perpendicular height of IE, then the length IB should be to the length DC, as the contraction of the materials of CD is to the contraction of the materials of which IB is constructed, added to the contraction in perpendicular height of the materials of which IE is constructed. These lengths, in this case, might be taken at once; but it is much more convenient to have the power of fixing them by experiment, after taking them from measure as nearly as may be.

Therefore, to have a means of raising the point I higher or lower in proportion to ED, whose ends are always to be at the same distance from one another, fig. 2. represents the means of altering the point I in proportion in height to E. The frame AAAA is fixed to the substance which connects the points I and E by any means. In the clock which I have constructed, the material which connects I and E is wood, as will be described afterwards. The frame is brass; it is fixed to the wood by the screws B B, and two other opposite ones which are hid in the drawing. They are so fixed that the point I shall be nearly in the middle between the upper screw B, and the lower screw B, and so that the part of the frame DDDD shall project backwards, and carry the part of the frame EEEE behind the frame which forms the connection between I and E, so as to be parallel to it; of consequence perpendicular to the horizon. In this frame there is seen, at the upper part, in the drawing, a dove-tail groove, in which, on both sides, another frame

GGGG slides, in the same manner as in that part of a transit instrument which renders one end of the axis higher or lower. This second frame is brought higher or lower by the screw HH. The rod IB, fig. 1, is a brass tube, represented by I I. There is a semicylindric cavity in the frame GGGG of the same diameter with the brass tube; a piece is applied over this frame, which is likewise a semicircular cavity, forming with the other cavity a whole cylinder, equal in diameter to the tube I I. This piece is attached to the frame GGGG by the screws L L; when these are screwed in tight, they occasion the tube I I to be embraced perfectly by the piece KK, and the semicylindric cavity in the frame G, so that the screw HH could not act if the tube I I was fixed; but if the screws L L are loosened, then they would leave the frame GGGG capable of being heightened or lowered by the screw HH. Now, if I I represent the rod IB, fig. 1, then if the centre of the screws L L be in an horizontal line, that line will cut the point I in an horizontal direction. The centres of these screws, therefore, may be considered as the point I in perpendicular height; wherefore if the point B, fig. 1, should become a fixed point, the point I may be lowered or heightened by bringing up or carrying down the centres of the screws L L by the screw HH.

If it be wished, therefore, by this apparatus to raise or depress the point I, fig. 1, it is necessary during the time of altering its height by the screw HH, that B, fig. 1, should become a fixed point; but that at all other times it should be a part perfectly free in its motion upwards or downwards.

In order to fix the point B fig. 1, in fig. 3 AAAA represents the frame of the clock, BB another frame fixed to this frame, and

projecting backwards to such a distance as to carry a tube fixed to it CC so far back, and in such direction, as to exactly coincide on its inside with the cylinder formed by the semicircular cavity in the frame GG, fig. 2, and the cylindric part of the piece KK, so that if they were continued they would form the same cylinder when the screws L L, fig. 2, are screwed home. This tube is made exactly to fit the tube I I, in the same manner that the outer brass tube of a telescope is fitted to the inner one. This tube CC is split open on one side, and is of such a degree of elasticity as to open when left to itself at this slit, so as to leave the tube I I entirely free. To the frame B is fitted a piece D, which consists of two semicylinders, connected together by one being screwed to the piece B at E, the other to the frame B at E on the other side. They are also connected by a part F, where they can be brought together or separated by the screw G. Now if the screw G be undone, then the two semicylinders will separate from one another, and allow the tube CC to open by its elasticity, and the tube I I to be at perfect liberty in expanding upwards or downwards. But if the screw G be screwed home, then the two sides of the piece F will embrace the tube C, and shut it upon the tube I, so that it shall become fixed at this point. This apparatus may be placed any where between B and I, fig. 1. In the clock I have constructed, it is placed at the point F opposite to E, fig. 1.

If the point I be placed then too high, the clock will be found to go too slow if the heat be greater, too fast if it be less. If this should be found the case, then the screw G, fig. 3, is to be screwed home, the screws L L, fig. 2, are to be loosened, and the frame GGGG must be screwed downward by the screw H, which will carry along with it the piece KK,

therefore the centres of the screws L L which form the point I, fig. 1, in perpendicular height. Then the screws L L, fig. 2, are to be screwed home, the screw G, fig. 3, is to be loosened so as to leave the tube I I, which is the same in both figures, perfectly free and untouched by any of the apparatus excepting at the point I, the fixed point. The same thing is to be done, only in the reverse, if the clock be found to go too fast in a greater degree of heat, too slow in a greater degree of cold.

In the clock which I have constructed, the bar BC, fig. 1, is considered as inflexible. If it were flexible, a weight hung at C would occasion it to fall lower, and in consequence bring the rod CD lower, and a greater part of it below the point E; thus the pendulum would be lengthened. It is therefore necessary to make this rod as inflexible as possible; for this reason it is made of a strong brass bar, HK, fig. 3, which is farther strengthened by a brass bar LK, supported by the upright HL.

If a weight were hung at K, it would tend to draw the tube I out of the perpendicular towards K. To prevent this, another bar HM is carried exactly opposite, so that M H K shall form the same bar, the under surface of which is parallel to the horizon. At the end of this bar M, is appended a weight O, so that, supposing the line LH to be the axis of the tube I I continued, and perpendicular to the horizon, then the whole of the weight on the side of LH towards M, shall be equal to the whole of the weight on the side of LH towards P. P is the head of a screw, to the centre of which the rod CD, fig. 1, is attached; this screw passes through the end of the bar HP, in the same manner as the wire sustaining the

weight O passes through the end of the bar HM at N. The uses of this screw are to be seen in fig. 4, where HK represent the end of the bar HK, fig. 3, through which the screw A passes. The head of this screw P is toothed and divided. To the teeth there is a catch at K, which allows it to be turned backwards and forwards with a tolerable force, but keeps it in the same place until that force be applied to it. The upper part of the screw C, fig. 4, is a cylinder, which passes through a cylindric hole in the end of the bar HK, fitted to it so as to allow of being turned round without shaking. The screw itself passes through a female screw at D in the frame EF.

This frame, as well as the screw itself, is made of brass, and consists of a bar EF, which is perpendicular to the horizon; from which arise two pieces GG and EL, at right angles, therefore parallel to the horizon. In the upper piece EL is a female screw, through which the screw A passes; so that the head P, being turned round, will raise the frame EF or depress it. In the bottom part GF there is a slit MM, through which the rod NO passes. This rod passes through a piece of brass PP at Q, where it is fixed, so that by screwing forward the screw A, the point Q, and the rod NO consequently, will be raised up, and *e contra*. The point Q is placed exactly under the centre of the screw A.

This point Q is to be considered as the point C, fig. 1. For although in fact the part of the rod HK where the screw A passes, and rests upon the end of the rod HK, be the point C, fig. 1; yet if a part of the tube I I, fig. 3, at the point C be taken at an equal height with Q, fig. 4, as they are both of brass, both will expand equally. If the whole should be heated, the expansion of CH, fig. 3, will raise up the bar HK, and the ex-

pansion of the screw A, and the frame EF, will carry down the point Q, so that it shall always be at an equal height with the point C, fig. 3. The points C and Q, fig. 3, 4, therefore, being always of the same height, may be considered as the points B C, fig. 1. The rod CD, fig. 1, is steel wire, the whole length of which weighs 13 grains. It is watch pendulum wire, No. 3. The point E is at R, fig. 4.

SSSS, fig. 4, is the frame which connects the points I and E, fig. 1; to this frame the square brass bar I I is firmly fixed, so as to rise perpendicular from the frame SSSS; on the side VV of this bar a semicylindric piece of crystal is attached, so that the cylindric part shall be towards R, and so that a number of lines perpendicular to the horizon, tangents to this cylinder, shall pass through the slit MM.

WX is another square rod, with a crystal semicylinder also attached to the frame SSSS, so as to rise perpendicular to it, but sliding in the dove-tail groove XY so as that it is capable of being brought nearer or farther from the cylinder attached to the rod I I. This may be done by a screw. It is clear then that the wire NO will pass between the cylindric parts of these two cylinders.

If the screw Y was screwed so as to make the cylinders touch one another, all but the exact thickness of the wire NO, then it is clear that the under part of the wire, from V to O, would become flexible at V, but then the expansion of the tube I I, fig. 3, would not lower or raise the part of the wire VO so as to keep it always of an equal length; but if the cylinders were opened the least farther, then the expansion or contraction of the tube I I, fig. 3, would raise or depress the part of the wire between the cylinder, and render the pendu-

lum always of the same length, whatever be the heat; and thus a pendulum may be formed, according to what has been demonstrated, always of one length.

On considering the several different methods of finding a measure of lengths which could be always and universally ascertained, I am persuaded that the taking the difference of the length of two pendulums, vibrating different times, appears not only to be the most perfect, but the easiest attainable. Mr. WHITEHURST contrived an apparatus for the purpose of ascertaining this difference, an account of which was read in the Royal Society, and afterwards withdrawn and published by the author himself. After his death, I purchased this apparatus.

There was no means in it whatever of keeping the pendulum of the same length when the heat should vary; consequently it was impossible that any accurate admeasurement of the different lengths of two pendulums keeping different times could be ascertained. Mr. WHITEHURST, indeed, had endeavoured to keep his pendulum of the same degree of heat; but I know from many experiments, among which some were for hatching eggs, how extremely difficult it is to maintain the same heat in any considerable mass, and that the means which may be employed to keep it within four or five degrees are almost totally inapplicable to pendulums; so that his experiments must have been defective. I therefore endeavoured to contrive a means of rendering the pendulum in his machine always of the same length, whatever the heat might be, by some addition to it. I thought of the principle, and formed the apparatus above described for this purpose.

It would be improper for me to repeat what has already

been laid before this learned Society; therefore I shall only mention briefly, that the frame of Mr. WHITEHURST's machine was formed of two pieces of very clean well seasoned deal, to which was fixed the apparatus for rendering the wire flexible of which his pendulum was formed at the point Q, fig. 4, but there were no semicylindric pieces; the two square pieces came together, so as to make the top of the pendulum at their under surface; these pieces could be brought away from one another by the screw Y, so as to leave the wire free. The use of this was, by the screw L, fig. 4, to adjust the pendulum to its proper length, which has in this apparatus a considerable advantage, as it is not necessary, in the form I have given to this apparatus, to stop the clock in order to adjust it. These pieces of wood are mortised into a transverse piece of deal at the top and at the bottom firmly. Before I attempted to make a very perfect machine on these principles, I resolved to try how far this frame of wood might serve to connect the points I and E, fig. 1, and procured the apparatus for altering the point I, screwed on to one of these perpendicular pieces of wood on one side, and to the other on the other side. The pendulum itself serves as a plummet to place them perpendicular. In Mr. WHITEHURST's machine the screw at L, fig. 4, went through a piece of brass, and rested upon it, fixed to the top of the clock-case. But in my construction of it, when the length of the rod IB, fig. 1, is adjusted, the clock has nothing to do with the clock-case, excepting with that part of the wooden frame which connects the point I with the point E, fig. 1. If I had been, or were to construct a machine for this purpose *ab origine*, instead of these two pieces of fir, I should employ a solid piece of brass, and make two cylindric cavities into it, parallel to one

another, and in these cavities place two glass tubes, about two inches diameter, perpendicularly upwards, which may be done by various means; and, while in this situation, having heated them gradually to the heat of melted lead, I should pour in melted lead, so as to fix them in their places when it cooled. The apparatus for fixing the point I, and that for fixing the tube I I, fig. 2 and 3 at F, fig. 1, being also of brass, in heat they would always expand, and in cold contract, equally; so that the glass tubes would keep always at an equal distance from one another, and equally perpendicular. Glass is not only very little apt to contract and expand by heat, but free from any such disposition from moisture or dryness, which is not the case with wood.

Having added the apparatus I have described to Mr. WHITEHURST's machine, I set it a going, expecting, in the situation I placed it, only some approach towards accuracy in the length of the pendulum. I fixed beside it a transit which belonged to Mr. LUDLAM, the principal parts of which were made by Mr. RAMSDEN, the object-glass was a four-feet focus achromatic by DOLLOND. I found my meridian mark at about three quarters of a mile distance. I likewise borrowed, from my friend Mr. STEVENS, a clock with a gridiron pendulum, made by GRAHAM for his father Dr. STEVENS, in order to compare them together when I had no observations. There were several trivial circumstances, which baffled the experiments for some time, not worth relating, one only excepted; which was, that the curvature of the wire, acquired by its being wound round a pirn, was not entirely unfolded for some months, so that the clock went slower and slower during that time. At length this difficulty was overcome; I then began to observe with

GRAHAM'S clock, in order to adjust the length of the pendulum, but found irregularities frequently take place. I then adjusted it by observation, and soon found that GRAHAM'S clock went much more irregularly than my own. I adjusted it by turning the head of the screw at L, fig. 4, until the clock came to lose seven-tenths of a second in 24 hours. I did not think it worth while to bring it nearer; I then began to observe, and carried on the observations, when the weather permitted, for about nine months, during which the thermometer had fallen so low as 15° of FAHRENHEIT, in the clock case, and risen as high as 84; and with considerable variations. Unfortunately I have mislaid or lost the particulars of each observation; but I have preserved the greatest difference from the rate of its going. Counting on, according to the rate of its going, during the whole time it never exceeded the sum, half a second, nor was ever less than half a second, whether it was taken from day to day, month to month, or from any one to any other period during the observation.

Undoubtedly, therefore, notwithstanding the errors that might have arisen from the expansion of the wood by moisture, and from the unsteadiness of the building in which it was placed, it certainly performed better than any other time-piece that has been made; and perhaps affords a principle which may be used in fixed observatories for keeping time with certainty, by easy and not very expensive means; and of determining, with the rest of Mr. WHITEHURST'S apparatus, the difference between the lengths of two pendulums swinging equal arches of circles of different diameters, in any two given different times.

The astronomer royal has also suggested an improvement:

viz. instead of grinding the two crystalline pieces in a cylindric form, the lower part should be ground in a cycloidal form; then it would have the advantage of cycloidal cheeks, which no contrivance hitherto has been able to attain.

There are some farther observations necessary to be made, to enable workmen to construct clocks according to this principle, and some reflections upon its operation.

The manner of hanging a leaden weight to the pendulum, its proportion to the maintaining power, the manner of applying the pendulum to the clock, and the structure of the clock, are to be found in Mr. WHITEHURST's pamphlet; with only this difference, that the steel wire should go through a tube placed in the axis of the spherical lead weight, and be fixed at the bottom instead of the top of it. This, however, is of no great consequence if there be a power of altering the height of the fixed point I, fig. 1; because Mr. WHITEHURST's pendulum consisting partly of steel, partly of lead, therefore the point I must be adjusted to the joint expansions of lead and steel, if the wire be fixed at the top of the ball.

The first reflection that I shall make is, that the steel wire, the brass tube, and the materials which connect the points I E, being of different sizes, and different in their disposition to be heated or cooled, some one of them might be heated or cooled faster than another. But where good clocks are kept, the changes of the heat of the atmosphere are so slow, that no great difference can take place in the time that each of the parts rises to the heat of the atmosphere in the room where the clock is kept; none that could make any sensible error. As the difference of the time when they acquired the heat, would be compensated by the difference of the time when they

acquired the cold, it could hardly happen that any sensible difference in the going of the clock could arise in any period of twenty-four hours, whether transits of the sun or of any of the fixed stars were taken.

The wire in each vibration hangs, during a certain portion of that vibration, between the two cylinders, and touches neither of them: during that time, the point Q must be considered as the top of the pendulum, not the slit between the cylinders; but this part of the vibration may be so very small a proportion of it, as not to make any sensible error; and it is accompanied on the other hand by a very great advantage. Except in Mr. ARNOLD's compensation for heat in watches, in all the other modes a surface or surfaces necessarily slide over one another; whenever this happens, if heat, by expanding one of the bodies, is to make its surface slide over the other, it has two things to accomplish, to overcome the *vis insita* of the matter, and the attraction of the two surfaces to one another. When then there is heat enough applied just to overcome the *vis insita*, it would not be sufficient to overcome the attraction likewise, excepting the matter was infinitely hard and inelastic. Although the heat therefore be increased, the compensating parts at first do not move so much as to overcome both these resistances, afterwards the parts jerk on suddenly, and in many cases go beyond what they otherwise would have done. As none of the expanding parts are to slide upon one another in Mr. ARNOLD's compensation, and there is a time in every vibration, in the apparatus above described, when none of the expanding parts slide over any thing, this disadvantage is avoided.

Fig. 1.

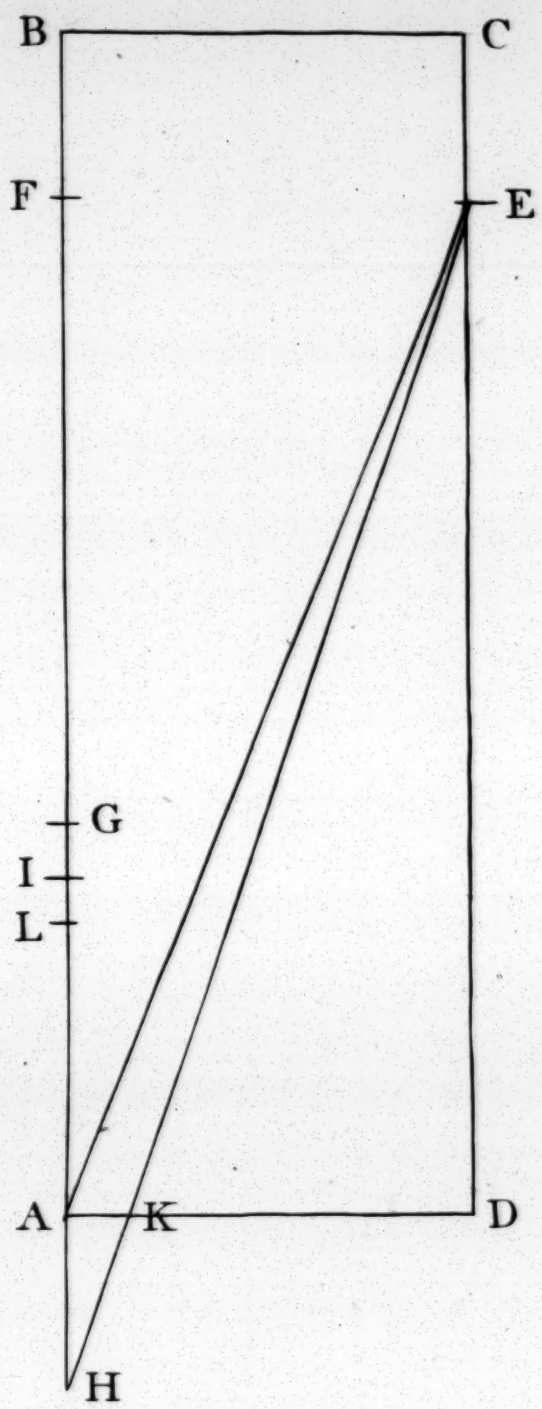
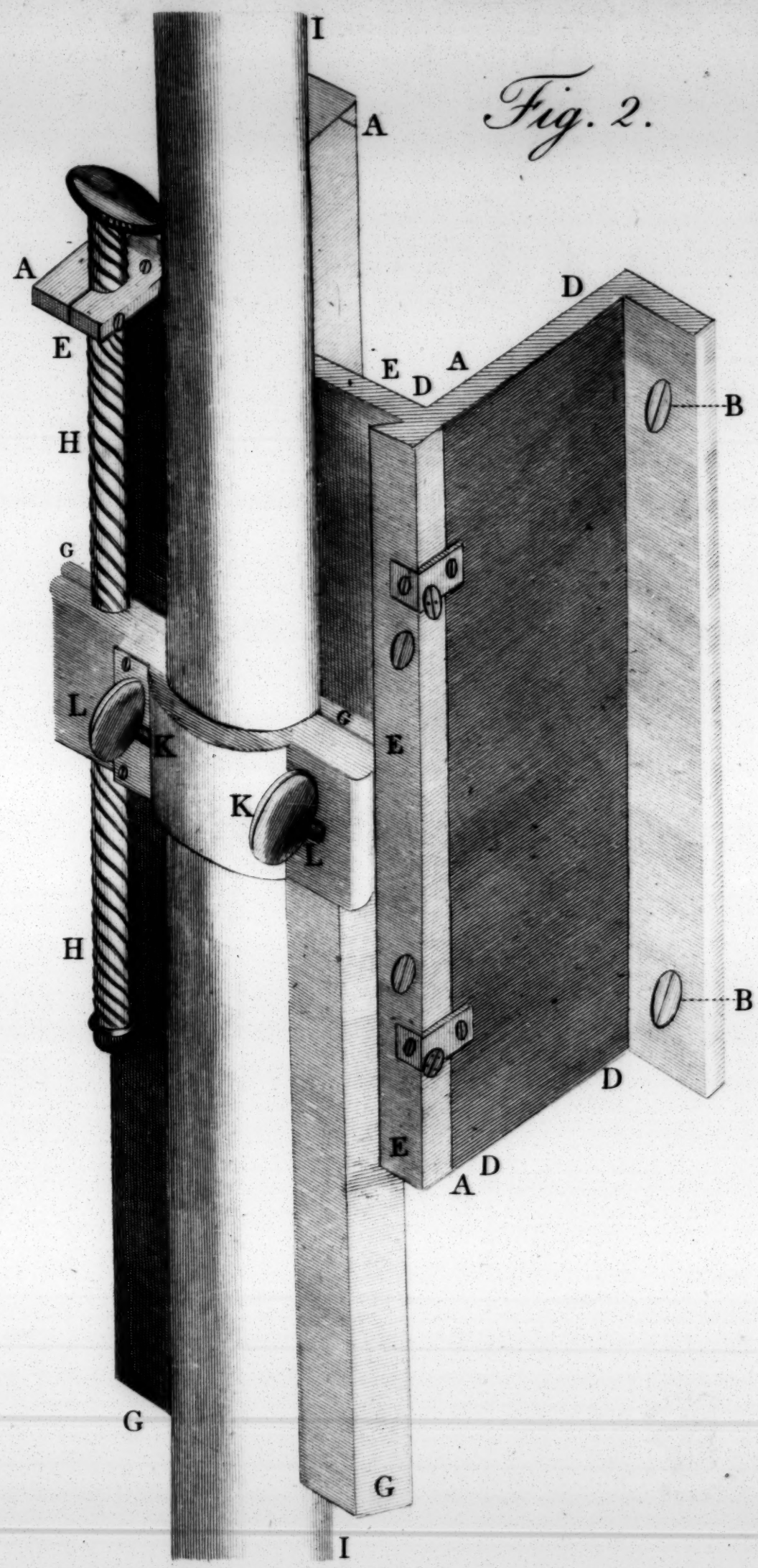


Fig. 2.



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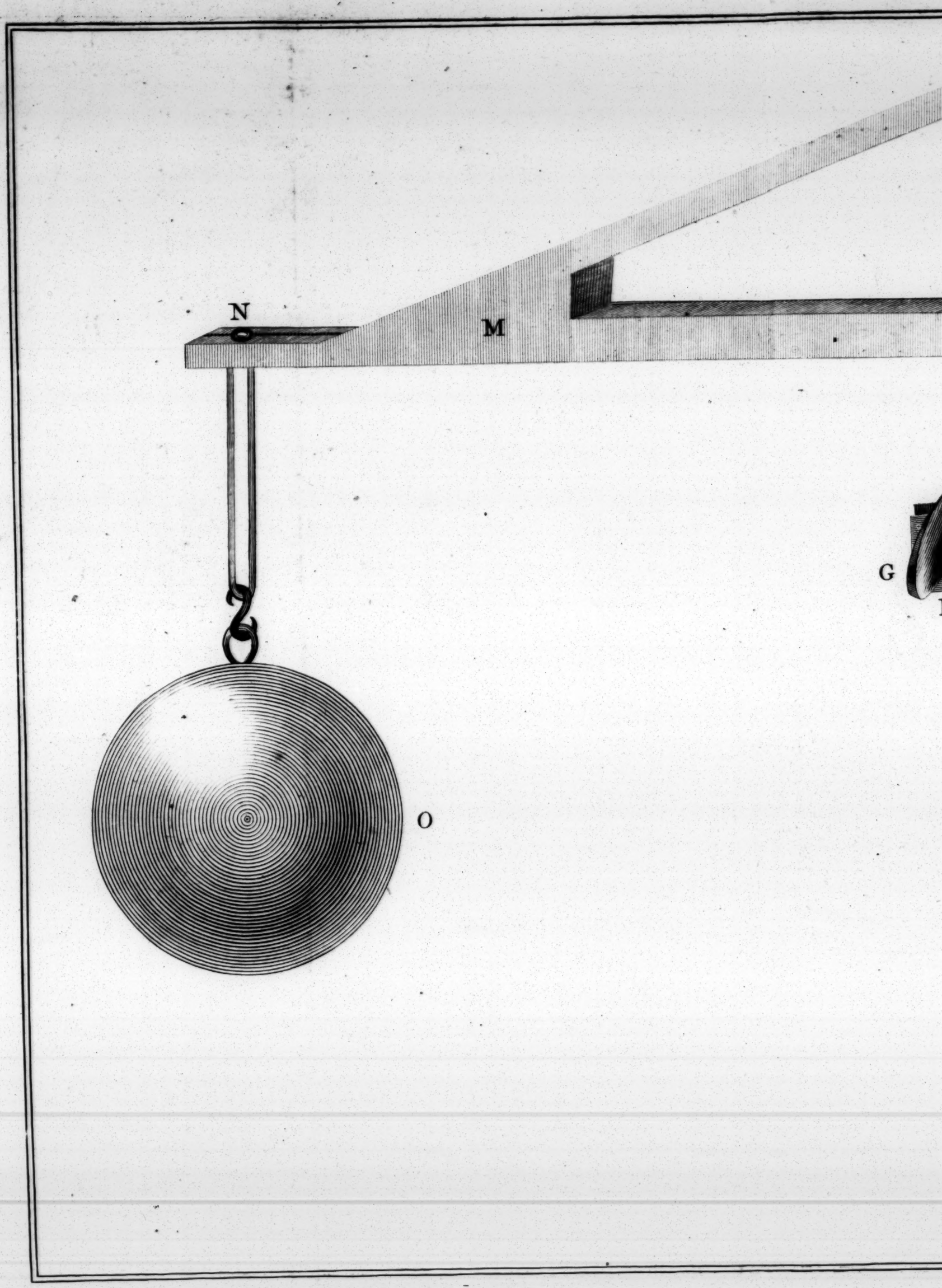

N
M
G
O

Fig. 3.

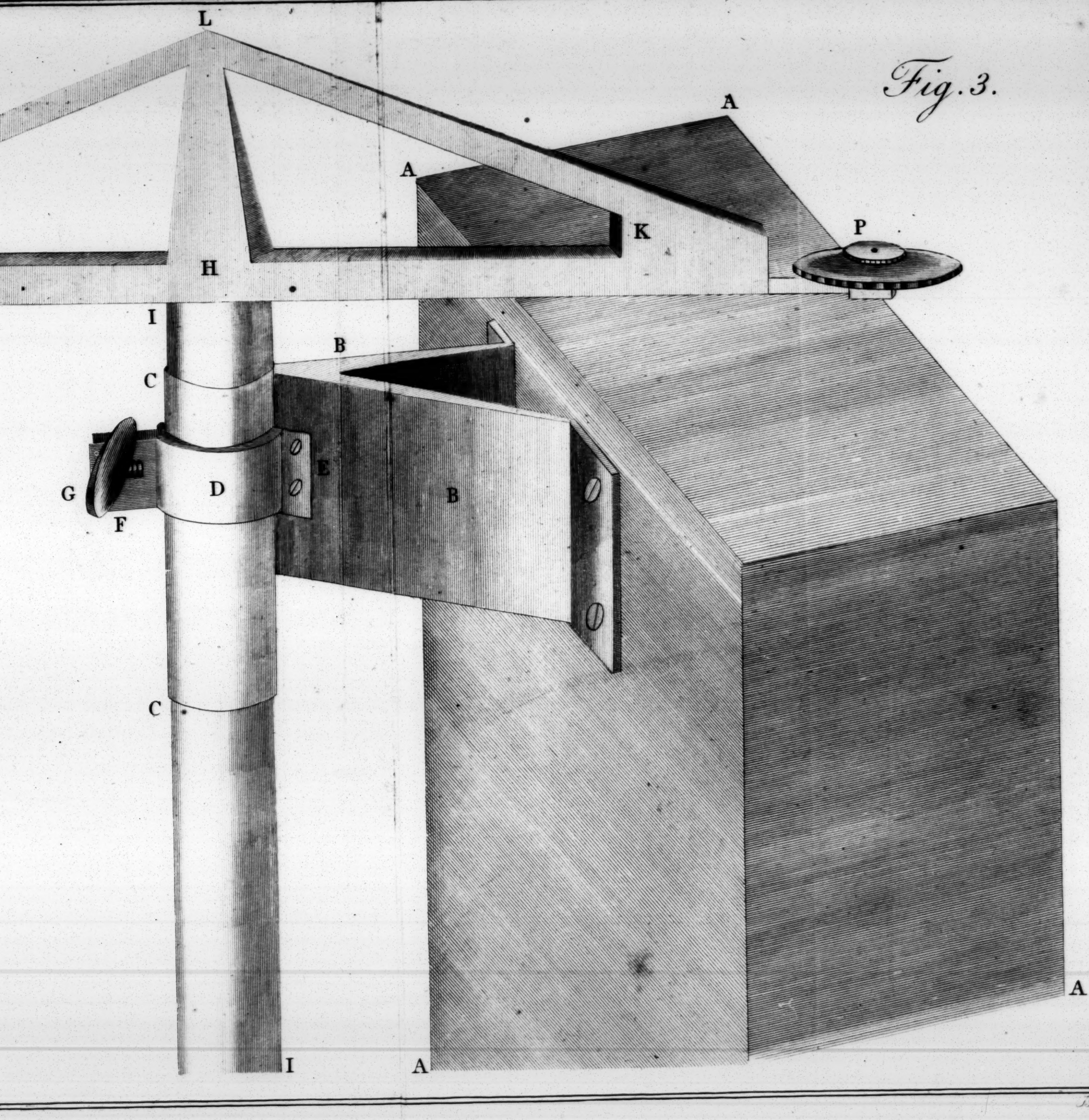
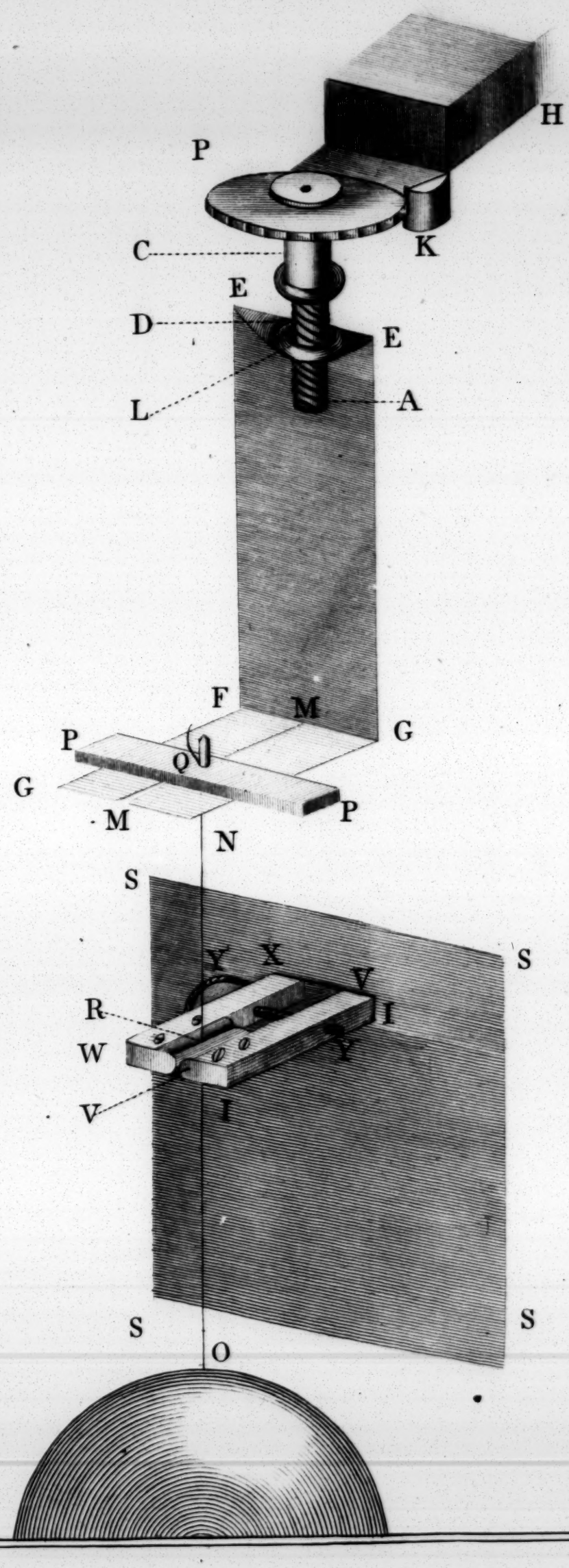


Fig. 4.



III. *Some Facts relative to the late Mr.* John Hunter's *preparation for the* Croonian *Lecture. By* Everard Home, *Esq. F. R. S.*

Read November 14, 1793.

Mr. Hunter having announced to the Royal Society that he would make the structure of the crystalline humour of the eye the subject of the Croonian lecture for the present year, and having, unfortunately for science, died before his observations on that subject were rendered complete, I feel it a duty I owe to his memory, as well as to the Society, to state the facts respecting this humour with which he had acquainted me; and shall subjoin an unfinished letter from Mr. Hunter to Sir Joseph Banks on the same subject.

It is now many years that Mr. Hunter has had an idea, that the crystalline humour was enabled by its own internal actions to adjust itself, so as to adapt the eye to different distances; and when the *Tænia hydatigena* first came under his observation as a living animal, he was surprised to see the quantity of contraction that took place in a membrane devoid of muscular fibres, but made use of the fact in his investigation of the structure of the crystalline humour of the eye.

Some time after this, having occasion to dissect the eye of the cuttle-fish, which he had frequently done before, but not with exactly the same view, he discovered in the crystalline

humour a structure which corresponded with the idea he had formed of its actions in the human eye. He found it composed of laminæ, whose appearance was evidently fibrous, for some depth from the external surface; but becoming less and less distinct, till at last this fibrous appearance was entirely lost, and the middle, or central part of the humour, was compact and transparent, without any visible laminæ. From this structure it would appear, that in the eye of the cuttle-fish the exterior parts of the humour are fibrous, the interior parts not; so that the central part is a nucleus round which the fibrous coverings are placed. The preparations which demonstrate these facts will be laid before the Society.

As the structure of the crystalline humour in the cuttle-fish differs in nothing from that of the same humour in other animals, but in the distinctness of the fibrous appearance, Mr. HUNTER was led to consider that the exterior part in all of them was similar, although no appearance of fibres could be demonstrated.

What I have here explained, I was acquainted with at the time I had the honour of giving the CROONIAN lecture, in which I examined the different structures endowed with muscular action; and was desirous that Mr. HUNTER would, either of himself, or through me, communicate these observations to the Society; but this he declined doing till he had ascertained, by experiment, whether any muscular effect was really produced; and the hope of being assisted by Mr. RAMSDEN made him, from time to time, put off making his experiments.

In the course of this season he began his experiments, which were founded upon the analogy that ought to exist between

this humour, if muscular, and others of a similar structure, which led him to expect that they would be acted upon by the same stimuli: and having found that a certain degree of heat, applied through the medium of water, will excite muscular action, after almost every other stimulus had failed, it was proposed to apply this to the crystalline humour, and ascertain its effects.

The crystalline humour taken from animals recently killed, must be considered as being still alive. Such humours were to be immersed in water of different temperatures, and placed in such a manner as to form the image of a lucid well defined object, by a proper apparatus for that purpose, so that any change of the place of that image from the stimulating effects of the warm water upon the humour would be readily ascertained. These were the experiments which Mr. HUNTER had instituted and begun; but in which he had not made sufficient progress to enable him to draw any conclusions.

To Sir JOSEPH BANKS, *from Mr.* HUNTER.

Sir,

When I did myself the honour of giving in my claim to the discovery of the crystalline humour being muscular, and proposed to make it the subject of the CROONIAN lecture, I did not foresee that any thing could prevent me from fulfilling my promise; but since that time, what with my state of health, which does not allow me to be very active; the hurry of official business on account of the war, and my brother-in-law, Mr. HOME, being employed on the medical staff, I have not had the power of repeating my experiments, and drawing out,

to my satisfaction, the many conclusions which are the result of such a power in this humour.

The laws of optics are so well understood, and the knowledge of the eye, when considered as an optical instrument, has been rendered so perfect, that I do not consider myself capable of making any addition to it; but still there is a power in the eye by which it can adapt itself to different distances far too extensive for the simple mechanism of the parts to effect. This power writers upon this subject have been at great pains to investigate and explain. The motion of the crystalline humour forwards and backwards, was asserted by some to be the cause; while others supposed in the eye a power to alter its shape, so as to shorten or lengthen its axis, which altered the distance between the crystalline humour and the point of impression; but we should consider that a part of the eye is itself a refractor, and that if its shape be altered so as to remove the crystalline humour from the point of impression, in order to enable it to bring a distant object to its proper focus on the retina, this effect will be in some degree counteracted by the anterior part of the eye refracting more than before, by being rendered more convex. But we have, in fact, no power capable of producing this effect; for the straight muscles, so far from appearing to have this power, have been even supposed to flatten the eye, and shorten its axis: and it is very possible that the action of these muscles is such as tends to both effects; but being in opposition to each other, the eye retains its shape, the insertion of these muscles being much more forwards than appears to be necessary for the simple motions of the eye. Further, when we consider that in many animals the shape of the eye is unalterable, as in all of the

whale tribe, the sclerotic coat being above half an inch thick, and composed of a strong tendinous substance. In many fish this coat is composed of cartilage; and in all birds the anterior part of it is (I believe) composed of bone. From all these considerations, I saw no power that could adapt the eye to the various distances of which we find it capable in the human body, unless we suppose the crystalline humour to be varied in figure, which can only be effected by a muscular action within itself. With this idea strongly impressed upon my mind, and finding that in many animals, when the crystalline humour was coagulated, it had a fibrous structure like muscles, I confess it seemed to me to confirm it; but as this might to others appear only conjecture, requiring some proof, I set about such experiments as were best adapted for that purpose. Knowing that in all violent deaths the muscles contract, I supposed the crystalline humour, if muscular, would show signs of this effect; for which purpose I got the eyes of bullocks when removed from the sockets, the moment the animal was knocked down, and while the eyes were warm the humours were removed."

Mr. HUNTER had proceeded thus far in the account of his experiments, when he was suddenly, and very unexpectedly, carried off; and as he has left no notes upon this subject, I am unable to make any addition to the account I have already given.

Mr. HUNTER's laying claim to the discovery of a fibrous structure in the crystalline humour, which had been observed long before, and described by the accurate LEUWENHOEK, may appear to require some explanation. The discovery of a fibrous

appearance in that humour, appertains to LEUWENHOEK; but the discovery of an eye in which this structure of the crystalline humour was perfectly distinct, and in which all the circumstances, of course, and situation, could be determined, is due to Mr. HUNTER: and if it should be found by future observation and experiments, that this structure, which is different from any that has hitherto been described, is capable of producing consequent actions and effects, sufficient to explain the adjustment of the eye to different distances, it will not be considered as a small, or unimportant discovery.

The melancholy event which has deprived this learned Society of so valuable a member, and which has taken from me so able an instructor, so rare an example, and so inestimable a friend, is too recent, to make any apology necessary for the shortness, or incorrectness of this account. I thought it due to the memory of my friend, that no promise of his, however inadequate I feel myself to the performance, should be left unfulfilled; and the circumstances of distress, under which it has been drawn up, will procure for me every indulgence from this learned Society.

Leicester Square,
Nov. 4, 1793.

EVERARD HOME.

EXPLANATION OF THE PLATE, Tab. V.

Fig. 1st. A transverse section of the crystalline humour of the eye of a cuttle-fish, to shew its structure; the central part is transparent, but the others are opaque, having been coagulated by proof spirits; and give the appearance of distinct fibres surrounding the central part.

Fig. 1.

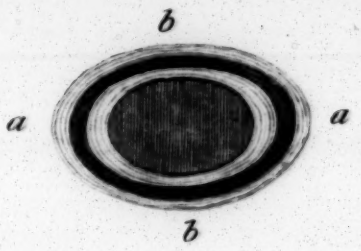


Fig. 2.

These fibres are not uniform circles or ovals, since the layers are of different thicknesses in particular parts; *aa* the fibres where they are most numerous; *bb* where they are least so.

Fig. 2d. A section of the crystalline humour, the central part being removed, to shew the fibrous structure of the surrounding laminæ.

IV. *Observations of a quintuple Belt on the Planet Saturn.* By William Herschel, *LL. D. F. R. S.*

Read December 19, 1793.

EVERY analogy that can be traced in the appearance of the planets, seems to throw some additional light on what we know of them already. In some of my former papers I have established the spheroidical form of the planet Saturn, and pointed out the motion of a spot on its disk. From the first of these may be inferred a considerable rotation on its axis; while the latter goes a step farther, and shews that it has such a motion. My late observations seem to hint to us, that the period in which it revolves is, probably, not of a long duration.

They are as follows:

Nov. 11, 1793. 3^h 35′, 7-feet reflector, power 287.

Close to the ring of Saturn, where it passes across the body of the planet, is the shadow of the ring; very narrow, and black. See Tab. VI. fig. 1.

Immediately south of the shadow is a bright, uniform, and broad belt.

Close to this bright belt is a broad, darker belt; which is divided by two narrow, white streaks; so that by this means, it becomes to be five belts; namely, three dark, and two bright ones; the colour of the dark belt is yellowish.

The space from the quintuple belt towards the south pole of the planet which is in view, is of a pale, whitish colour; less bright than the white equatorial belt, and much less so than the ring.

The globular form of Saturn is very visible, so that it has by no means the appearance of a flat disk.

Nov. 13, 3^h 30′. The quintuple belt on Saturn is as it was Nov. 11. I saw it three hours ago, and several times since, without any visible change.

Nov. 19, 3^h 14′. The southern belt of Saturn is still divided into five. The evening is not clear enough to observe changes in it, if there were any.

Nov. 22, 2^h 32′. The quintuple belt on Saturn remains still the same; power 287.

With 430, I see the same very distinctly, but the small divisions have hardly light enough when so much magnified.

I viewed the same belt with four different object specula. One of them shewed the divisions uncommonly well.

Dec. 3, 0^h 35′. 7-feet reflector; power 287. The quintuple belt upon Saturn remains as it was Nov. 22.

I tried several double and plano-concave eye-glasses, but found them all defective in figure except one, and that being of one inch focal length, the power was too low to expect seeing these belts well with it.

The smallness of the field of view, with astronomical objects is not so disagreeable as it is generally supposed to be; for the eye may have a motion before the lens, and by that means a small luminous object, when all the rest of the field is dark, and while the telescope remains in the same situation, may be seen for as long a time, passing through the field of a concave

eye-glass, as it can in a convex one; whereas with the latter, it is well known that such a motion of the eye can be of no use.

2^h 36′. 20-feet reflector; power 157, 300, 480. I see the quintuple belt very well.

We know that the planet Jupiter has many belts. Some remarkable instances of their being very numerous are recorded in my journal, one of which is accompanied with a figure. The observations are as follows:

May 28, 1780. Jupiter's belts are curved; and there are a multitude of them all over the body of the planet. See fig. 2.

Jan. 18, 1790. I viewed Jupiter with the 40-feet reflector. There were two very dark, broad belts, divided by an equatorial zone or space, the colour of which was of a yellow cast. Next to the dark belts, on each side, towards the poles, were bright and dark small belts, alternately placed, and continued almost up to the poles, both ways.

In taking out fig. 2. from my journal, I perceive one so very unlike it just before, that I am induced to give it here, though rather foreign to my present purpose. It contains, however, an observation which it will not be amiss to record.

April 6, 1780. I had a fine view of Jupiter, and saw, as soon as I looked into the telescope, without having any previous notice of it, the shadow of the 3d satellite, and the satellite itself, upon the lower part of the disk. See fig. 3. The shadow was so black and well defined, that I attempted to measure it, and found its diameter by the micrometer 1″,562.

This measure of the shadow should be checked by the following observation.

March 15, 1792. 11^h 54′. With the 20-feet reflector, and a power of 800, I estimate the apparent diameter of the largest

of Jupiter's satellites to be less than one-fourth of the diameter of the GEORGIAN planet, which I have just been viewing. With 1200, it seems also to be less, in the same proportion. With 2400, I can plainly perceive the disk of the satellite. With 4800, the apparent diameter of the largest of the satellites is less than one-quarter of that of the GEORGIAN planet.

The analogy alluded to in the first paragraph of this paper, refers to the numerous parallel belts which we have noticed, in the above given observations, on the disks of Jupiter and Saturn.

That belts are immediately connected with the rotation of the planets will hardly be denied, when those of Jupiter are so well known always to lie in the direction of its equatorial motion. Since, then, it appears that the belts of Saturn are very numerous, like those of Jupiter, and are also placed in the direction of the longest diameter of the planet, it may not be without some reason that we infer the period of the rotation of the former to be short, like that of the latter.

The planet Mars, in all my observations, never presented itself with any parallel belts, nor do we observe such phænomena on the disk of Venus. The first is known to have a rotation much slower than Jupiter;* and the latter, according to the accounts of CASSINI and BIANCHINI, is certainly not one that moves quickly upon its axis.

However, I do not mean to enter into the strength of an argument for a quick rotation of Saturn, that may be drawn from the condition of its belts. The circumstance of a quin-

* See Phil. Trans. Vol. LXXI. Part I. page 134.

tuple belt, is adduced here with no other view, than merely to point out an analogy in the condition of the two largest planets of our system; and from thence to infer, that every conclusion on the atmosphere and rotation of the one, drawn from the appearance of its belts, will equally apply to the other.

Slough, near Windsor,
Dec. 14, 1793.

WM. HERSCHEL.

Fig.1.

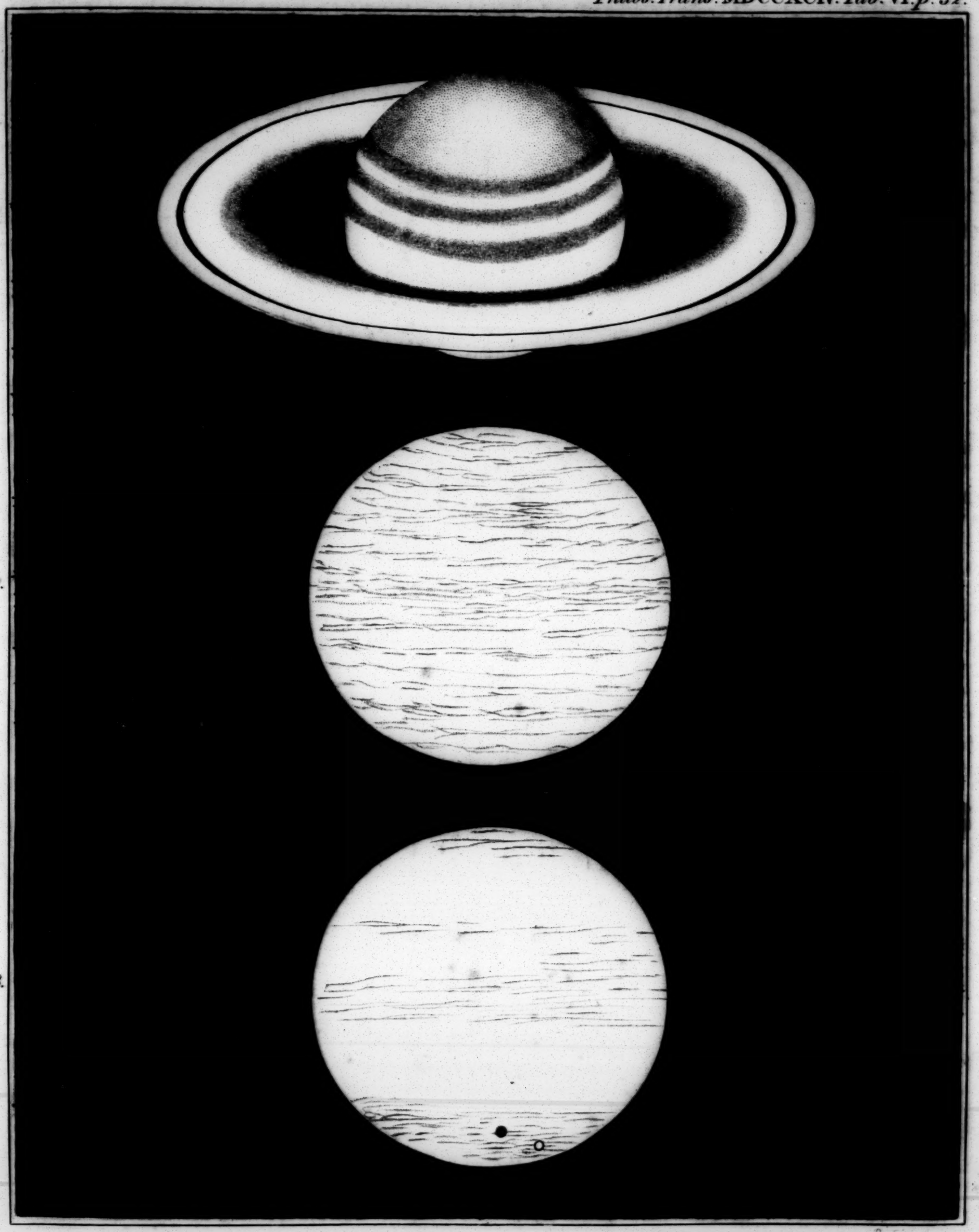
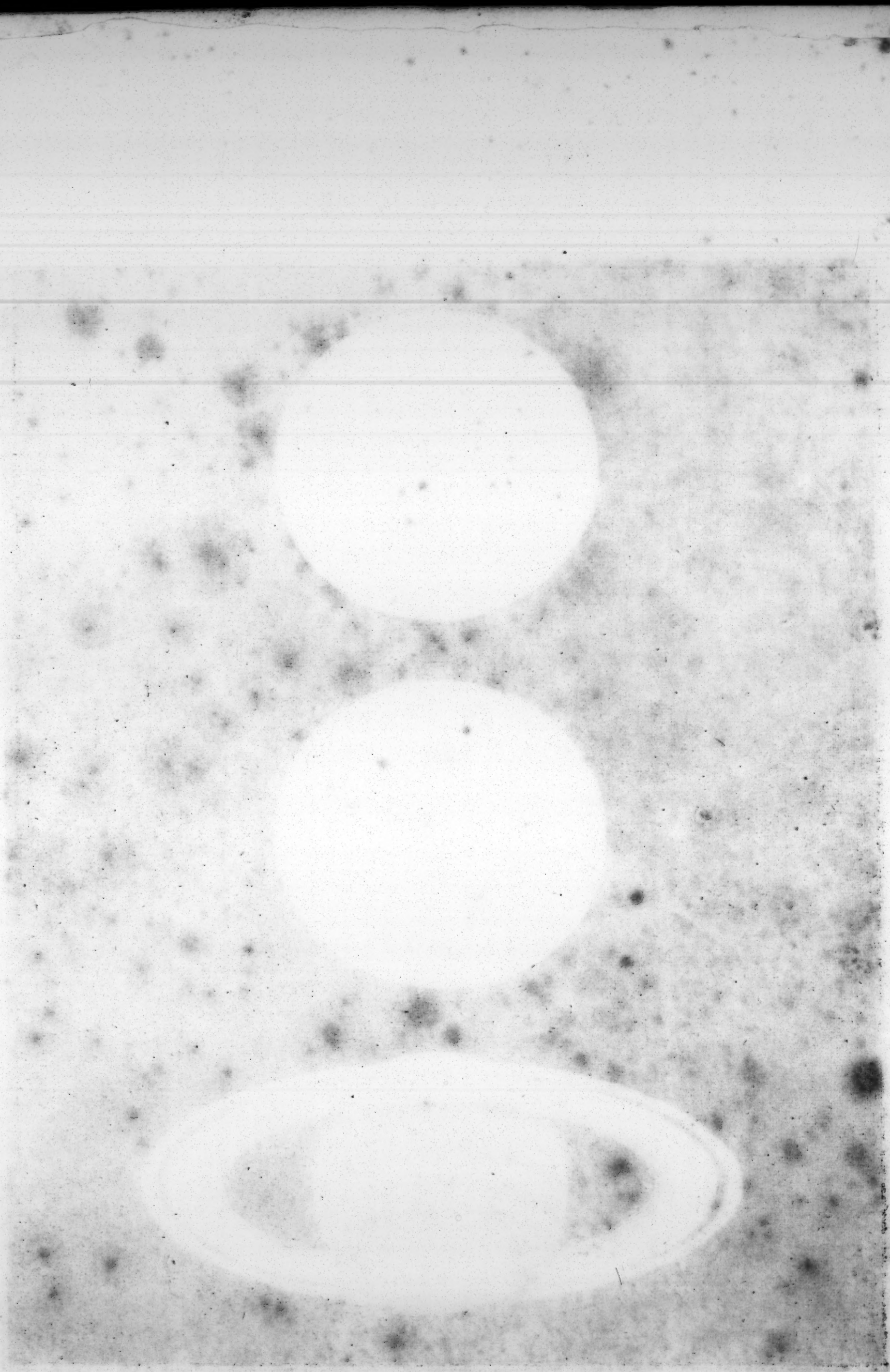


Fig.2.

Fig.3.

Barlow Jr.



V. *Observations on the fundamental Property of the Lever; with a Proof of the Principle assumed by* Archimedes, *in his Demonstration. By the Rev. S. Vince, A. M. F. R. S.*

Read December 19, 1793.

THE want of a demonstration of the property of the lever, upon clear and self-evident principles, has justly been considered as a great desideratum in the science of mechanics, as the most important parts of that branch of natural philosophy are founded upon it. ARCHIMEDES was, I believe, the first who attempted it. He supposes, that if two equal bodies be placed upon a lever, their effect to turn it about any point is the same as if they were placed in the middle point between them. This proposition is by no means self-evident, and therefore the investigation which is founded upon it has been rejected as imperfect. HUYGENS observes, that some mathematicians, not satisfied with the principle here taken for granted, have, by altering the form of the demonstration, endeavoured to render its defects less sensible, but without success. He then attempts a demonstration of his own, in which he takes for granted, that if the same weight be removed to a greater distance from the fulcrum, the effect to turn about the lever will be greater; this is a principle by no means to be admitted, when we are supposed to be totally ignorant of the effects of weights upon a lever at different distances from the

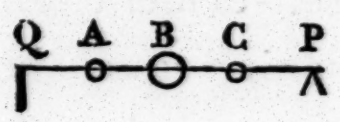
fulcrum. Moreover, if it were self-evident, his demonstration only holds when the lengths of the arms are commensurable. Sir I. NEWTON has given a demonstration, in which it is supposed, that if a given weight act in any direction, and any radii be drawn from the fulcrum to the line of direction, the effect to turn the lever will be the same on whichever of the radii it acts. But some of the most eminent mathematicians since his time have objected to this principle, as being far from self-evident, and in consequence thereof have attempted to demonstrate the proposition upon more clear and satisfactory principles. The demonstration by MAC LAURIN, as far as it goes, is certainly very satisfactory; but as he collects the truth of the proposition only from induction, and has not extended it to the case where the arms are incommensurable, his demonstration is imperfect. The demonstration given by Dr. HAMILTON, in his Essays, depends upon this proposition, that when a body is at rest, and acted upon by three forces, they will be as the three sides of a triangle parallel to the directions of the forces. Now this is true, when the three forces act at any point of a body; whereas, considering the lever as the body, the three forces act at different points, and therefore the principle, as applied by the author, is certainly not applicable. If in this demonstration we suppose a plane body, in which the three forces act, instead of simply a lever, then the three forces being actually directed to the same point of the body, the body would be at rest. But in reasoning from this to the case of the lever, the same difficulties would arise, as in the proof of Sir I. NEWTON. But admitting that all other objections could be removed, the demonstration fails when any two of the forces are parallel. Another demonstration is founded

upon this principle, that if two non-elastic bodies meet with equal quantities of motion, they will after impact, continue at rest; and hence it is concluded, that if a lever which is in equilibrio be put in motion, the motions of the two bodies must be equal; and therefore the pressures of these bodies upon the lever at rest, to put it in motion, must be as their motions. Now in the first place, this is comparing the effects of pressure and motion, the relation of the measures of which, or whether they admit of any relation, we are totally unacquainted with. Moreover, they act under very different circumstances; for in the former case, the bodies acted immediately on each other, and in the latter, they act by means of a lever, the properties of which we are supposed to be ignorant of. When forces act on a body, considered as a point, or directly against the same point of any body, we only estimate the effect of these forces to move the body out of its place, and no rotatory motion is either generated, or any causes to produce it, considered in the investigation. When we, therefore, apply the same proposition to investigate the effect of forces to generate a rotatory motion, we manifestly apply it to a case which is not contained in it, nor to which there is a single principle in the proposition applicable. The demonstration given by Mr. LANDEN, in his Memoirs, is founded upon self-evident principles, nor do I see any objections to his reasoning upon them. But as his investigation consists of several cases, and is besides very long and tedious, something more simple is still much to be wished for, proper to be introduced in an elementary treatise of mechanics, so as not to perplex the young student either by the length of the demonstration, or want of evidence in its principles. What I here propose to

offer will, I hope, render the whole business not only very simple, but also perfectly satisfactory.

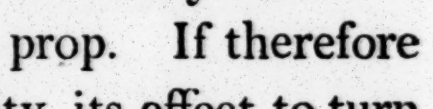
The demonstration given by ARCHIMEDES would be very satisfactory and elegant, provided the principle on which it is founded could be clearly proved; viz. *that two equal powers at the extremities, or their sum at the middle of a lever, would have equal effects to move it about any point.* Now, that the effects will be the same, so far as respects any *progressive* motion being communicated to the lever when at liberty to move freely, is sufficiently clear; but there is no evidence whatever that the effects will be the same to give the lever a *rotatory* motion about any point, because a very different motion is then produced, and we are supposed to know nothing about the efficacy of a force at different distances from the fulcrum to produce such a motion. Besides, the two motions are not only different, but the *same* forces are known to produce *different* effects in the two cases; for in the former case the two *equal* powers at the extremities of the arms produce *equal* effects in generating a *progressive* motion; but in the latter case they do *not* produce *equal* effects in generating a *rotatory* motion. We cannot therefore reason from one to the other. The principle, however, may be thus proved.

Let A C, be two equal bodies placed on a straight lever, A P moveable about P; bisect A C in B, produce P A to Q, and take B Q = B P, and suppose the end Q to be sustained by a prop. Then as A and C are similarly situated in respect to each end of the lever, that is, A P = C Q, and A Q = C P, the prop and fulcrum must bear equal parts of the whole weight; and therefore the prop at Q will be pressed with a



weight equal to A. Now take away the weights A and C, and put a weight at B equal to their sum; and then the weight at B being equally distant from Q and P, the prop and fulcrum must sustain equal parts of the whole weight, and therefore the prop will now also sustain a weight equal to A. Hence if the prop Q be taken away, the moving force to turn the lever about P in both cases must evidently be the same; therefore the effects of A and C upon the lever to turn it about any point are the same as when they are both placed in the middle point between them. And the same is manifestly true if A and C be placed without the fulcrum and prop. If therefore A C be a cylindrical lever of uniform density, its effect to turn itself about any point will be the same as if the whole were collected into the middle point B; which follows from what has been already proved, by conceiving the whole cylinder to be divided into an infinite number of laminæ perpendicular to its axis, of equal thicknesses.

The principle therefore assumed by ARCHIMEDES is thus established upon the most self-evident principle, that is, that *equal* bodies at *equal* distances must produce *equal* effects; which is manifest from this consideration, that when *all* the circumstances in the cause are equal, the effects must be equal. Thus the whole demonstration of ARCHIMEDES is rendered perfectly complete, and at the same time it is very short and simple. The other part of the demonstration we shall here insert, for the use of those who may not be acquainted with it.

Let X Y be a cylinder, which bisect 

in A, on which point it would manifestly rest. Take any point Z, and bisect Z X in B, and Z Y in C; then, from

what has been proved, the effects of the two parts ZX, ZY to turn the lever about A is the same as if the weight of each part were collected into B and C respectively, which weights are manifestly as ZX, ZY, and which therefore conceive to be placed at B and C. Now $AB = AX - XB = \frac{1}{2}XY - \frac{1}{2}XZ = \frac{1}{2}YZ$; and $AC = AY - YC = \frac{1}{2}XY - \frac{1}{2}ZY = \frac{1}{2}XZ$; consequently $AB : AC :: \frac{1}{2}YZ : \frac{1}{2}XZ :: YZ : XZ ::$ the weight at C : the weight at B.

The property of the straight lever being thus established, every thing relative to the bent lever immediately follows.

VI. *Account of some Particulars observed during the late Eclipse of the Sun.* *By* William Herschel, *LL.D. F. R. S.*

Read January 9, 1794.

It will be proper to remark that my attention, in observing this eclipse, was not directed to the time of the several particulars which are usually noticed in phænomena of this kind; such as the beginning, the end, and the digits eclipsed. I was very well assured that the care of other astronomers would render my endeavours, in that respect, perfectly unnecessary. The only view I had was, to avail myself of the power and distinctness of my telescopes, in order to see whether any appearances would arise that might deserve to be recorded; and the following particulars will, at least, serve to point out the way for similar observations to be made in other eclipses, where different circumstances may chance to afford an opportunity for gathering some addition to our knowledge, with regard to the nature and condition of the moon, or of the sun, and perhaps of both these heavenly bodies.

Sept. 5, 1793. $8^h\ 40'\ 3''$ by the clock.* My attention being directed to the place where I supposed the first impression would be made, I perceived two mountains of the moon enter the disk of the sun, as delineated at *a*, *b*, fig. 1, Tab. VII. The

* By account, my sidereal time-piece was about $5'\ 1'',7$ too forward; but, as no transits had been lately taken, there may be an error of some seconds.

time of their beginning to appear, when I saw them first, might be one or two seconds past.

9^h 5′. 7-feet reflector; power 287. The internal, luminous angle made on the sun, by the intersection of the limb of the moon, which is now but little more than a rectangle, is perfectly sharp up to the very point. It is not in the least disfigured by the refraction of the lunar atmosphere. The present shape of the angle, however, is not favourable for shewing the effects of that atmosphere.

9^h 17′. The luminous angles of the sun's preceding and following limbs, which are now acute, remain perfectly sharp. One of them, indeed, was disfigured, a little while ago, by the entrance of a mountain of the moon, but is now restored to its sharpness.

10^h 5′. I delineated the appearance of the limb of the moon upon the sun, and found its mountains as in fig. 2. At *a* was a large *table mountain*, as it may be called, from its flat appearance; at *b* and *c* were elevated, pointed rocks. Their appearance changing pretty fast, no great accuracy can be expected in their expressed relative situation.

I suppose the height of the most elevated of these mountains not to exceed a mile and an half; for, on drawing several of them upon the segment of a large circle, so as to look like what they appeared when projected upon the sun, I found them to be from the 1500dth to the 2000dth part of the diameter of that circle. Then, putting the moon's diameter, as M. DE LA LANDE states it, at 782 French leagues, or 2151 English miles, we find the 1500dth part of this to be less than one mile and an half for the highest; and the 2000dth part, not quite one mile and a tenth for the lowest.

I attended all this time to the appearance of the sharp limb *a b c* of the sun, fig. 3, and suspected, sometimes, a little bending of the cusps outwards, as expressed at *b* in fig. 4; but upon long, and attentive inspection, I could not satisfy myself of its reality. If there was a bending, it did probably not amount to one second of a degree; for, having formerly been much in the habit of measuring the moon's mountains,* the quantity of one second, on its disk, was still familiar enough to me to estimate it pretty exactly.

10^h 15′. I looked out with the natural eye for the planet Venus, and soon perceived her. In the telescope, with 287, she appeared very sharp and well defined, and was a little gibbous.

It may seem, perhaps, extraordinary that in the trial above mentioned, the eye should be able to ascertain the proportion of a quantity so little as the fifteen hundredth, or two thousandth part of the diameter of the moon; but the experiment may be easily repeated in the following manner:

Upon a line, six or eight inches long, drawn on a sheet of paper, make several small marks, representing mountains on the projected circumference of a large globe. The paper being then placed in a proper light and situation, withdraw the eye to the distance of 7, 8, or 9 feet, and take notice which of the marks appear of the same size, and distinctness, with the

* In the years 1779, 1780, and 1781. I did not measure, I suppose, less than an hundred mountains of the moon, in which I used three different methods: the projection of the tops of these mountains beyond the enlightened part of the disk; the length of their shadow on the surface of the moon; and their perpendicular projection on the full edge of the moon's limb. Some of these observations are contained in a former paper (see Phil. Trans. Vol. LXX. Part II. page 507); but most of them remain uncalculated in my journal, till some proper opportunity.

mountains they represent. Then, from the known angular magnitude of the moon, calculate its diameter, at the distance of your situation; this, multiplied by the power of the telescope, gives the diameter of a circle, to the circumference of which belongs the line, upon which are placed the marks above described. Now, measure the elevation of these marks, above that line, and you will obtain the proportion they bear to the diameter of the circle.

In my experiment, I found that I could plainly see some small protuberances at 9 feet distance, which were no higher than the 50th part of an inch. Then putting the diameter of the moon at 30′, we have the sum of the logarithms of the tangent of 30′; of the power 287; and of the 50ths of an inch contained in 9 feet; which, taken from the logarithm of the diameter of the moon in miles, gives the logarithm of ,16. By which we find, that so small a mountain as the $\frac{16}{100}$dth, or not much more than the sixth part of a mile, may be perceived and estimated, by the telescope and power that was used upon this occasion; and that, consequently, the estimation of mountains, near a mile and an half high, must become a very easy task.

Slough, near Windsor,
Dec. 30, 1793.

WM. HERSCHEL.

Fig. 1.

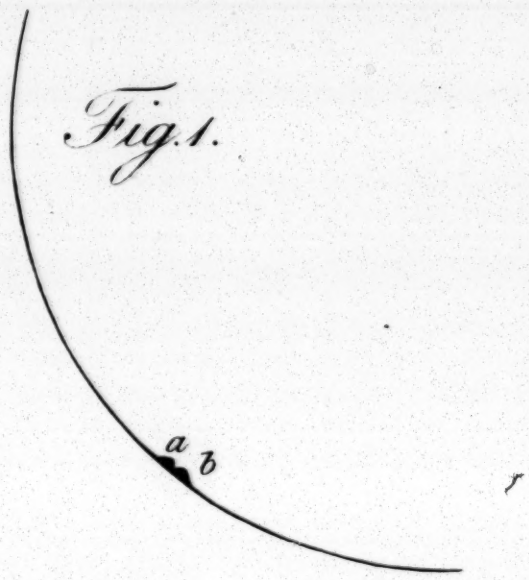


Fig. 2.

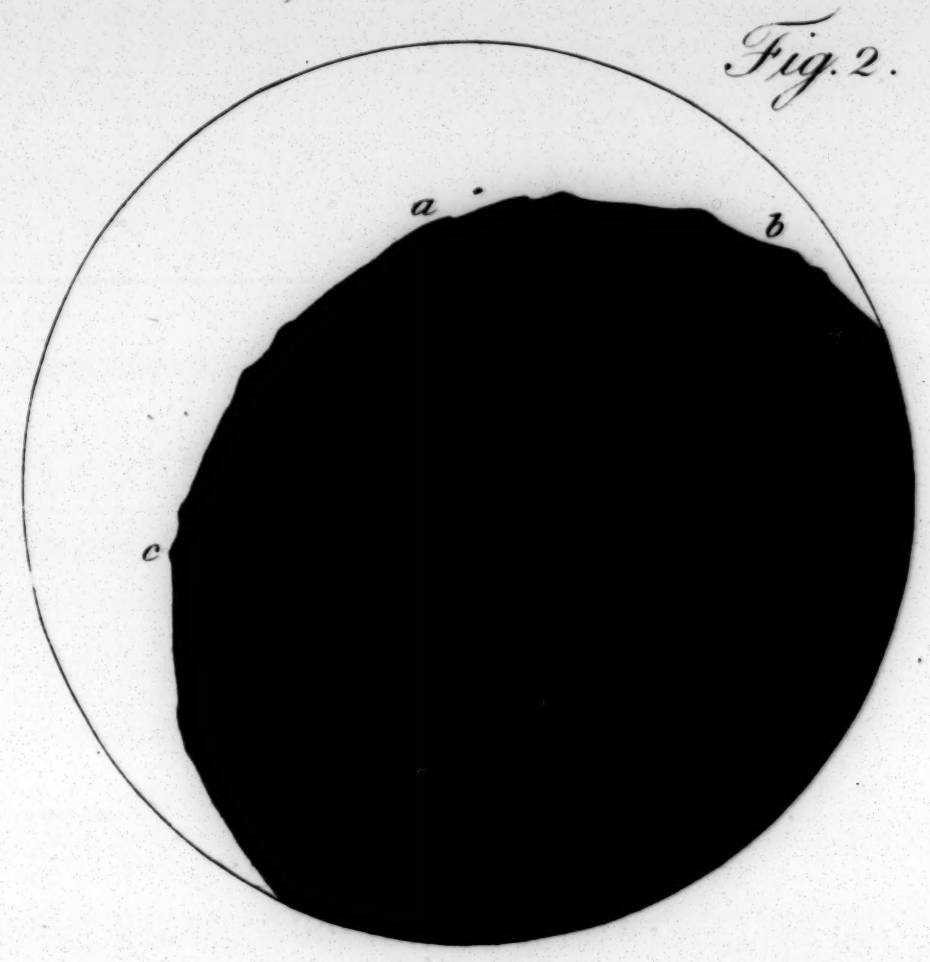


Fig. 3.

Fig. 4.

Basire sc.

VII. *The Latitudes and Longitudes of several Places in* Denmark; *calculated from the Trigonometrical Operations. By* Thomas Bugge, *F. R. S. Regius Professor of Astronomy at* Copenhagen.

Read January 9, 1794.

THE geographical surveying of Denmark was begun in the year 1762. The foundations of geographical maps are the trigonometrical operations, or great triangles, whose bases were measured with deal rods. The angles of the triangles were observed with a circular instrument of 1 foot radius; the divisions of this instrument are double, in 90 and 96 degrees. With this instrument the angles may be observed to a less error than 8″, and the sum of all the angles in every triangle very seldom have had a difference of 15″ from 180 degrees. For this reason the bases, measured at several places in Seland and Jutland, have very well agreed with the corresponding sides, computed through a long series of triangles, begun from the observatory at Copenhagen. I believe that a distance, found by those trigonometrical operations, is to be depended upon to $\frac{1}{20000}$th part of the whole. I beg leave to observe, that the Danish astronomers and geographers, for 31 years, have been before hand in making use of circular instruments, which now begin to be of a more general use in astronomical and geographical observations. The royal observatory at Copenhagen has, since the year 1781, been adorned with a

circular instrument of 4 feet radius, which, at least at that time, was the only circular instrument of that size.

By the trigonometrical operations, the meridian of Copenhagen, and of several other places, and a perpendicular to the meridian of the observatory, are drawn. The special position of villages, farms, and cottages, the situation of the coast, woods, rivers, ponds, moors, roads, are laid down by the plain table, on a scale of 2000 Danish or Rhenish feet to one decimal inch. After a reduction to $\frac{1}{6}$th part, to a scale of 1 Danish mile to 2 inches, we have published 9 geographical maps, which, as well for the geometrical exactness, as for the beauty of engraving, seem not to be unworthy of the approbation of foreigners.

I have described the instruments, and the methods of our geometrical surveying, and of the trigonometrical operations, in a treatise published in the Danish language at Copenhagen 1779, and translated into the German by Major ASTER at Dresden, 1787. In this paper I only shall lay before the Royal Society a new method of computing the longitude and the latitude of places, laid down by trigonometrical operations.

Let EAIH (Tab.VIII.) be an ellipsis; EH half the less axis; IH half the greater axis; A the observatory at Copenhagen; AV its vertical line; the angle V the complement to the latitude of the observatory. Then by the nature of the ellipsis. $AV = \frac{HI^2}{(HI^2 \sin.^2 V + HE^2 \cos.^2 V)^{\frac{1}{2}}}$. AN is a great circle, perpendicular to the meridian of Copenhagen. The tangent to the same meridian $AF = AV \times \text{tang. V}$. A *m n o p* . . . D is a series of triangles in the direction of the parallel of Copenhagen. *g t u r x* . . . G is a series of triangles in the direction of

the meridian GDE of a place G, whose longitude and latitude are to be calculated. For the first series of triangles may be taken the parallel, divided into small parts AB = BC = CD; and for the second series may be taken the meridian GD; because the arches of those circles are known by the triangles, and computed from the trigonometrical operations. FAGD in the 1st. fig. is laid down in fig. 2 upon a plane. The angles *a*, *b*, *c*, *d*, are equal to the angles A, B, C, D. The lines *af*, *bf*, *cf*, *gdf*, are equal to AF, BF, CF, GDF, touching the meridians AE, BE, CE, GDE in A, B, C, D. The angle *dfa* = DFA = AFB + BFC + CFD. For the place *g*, or G, are given the distance from the meridian of Copenhagen = *gk*, and the distance from the perpendicular = *ak*, and *af* = AF = AV × tang. V. In the case that *g* is more southerly than *an*, then *fk* = *af* + *ak*. If the place is northerly, then *fk* = *af* − *ak*. Hence tang. *dfa* = $\frac{gk}{fk}$. The complement to the angle *dfa* is the angle *fna* = *fgk*, which the meridian *gdf* makes with the perpendicular to the meridian of Copenhagen. Now DEA : DFA = AF : AM = tang. V : sin. V; therefore *the longitude of the place* G *from the meridian of Copenhagen* = DEA = DFA × $\frac{\text{tang. V}}{\text{sin. V}} = \frac{\text{DFA}}{\text{cos. V}}$.

Again, $gf = \frac{gk}{\text{sin. } afd} = \frac{fk}{\text{sin. } g}$. If the place *g* is more southerly than the perpendicular *an*, then *dg* = *gf* − *fd* = *gf* − *af*; if more northerly than *an*, in that case *dg* = *af* − *fg*. From hence *the latitude of the place g may be found.*

The following Table contains the latitudes of towns and places, with their longitudes from the royal observatory at Copenhagen, calculated from our trigonometrical operations.

Names of Places.	Sea or Country.	Latitude.	Longitude. In Degrees.	Longitude. In Time.
		° ′ ″	° ′ ″	h ′ ″
Landscrone - -	Sweden -	55 52 23	0 15 16	0 1 0,5 E.
Hveen (church) -	— —	55 54 38	0 5 56	0 0 23,75 E.
Kullen (light-house) -	— —	56 18 3	0 7 58	0 0 31,75 W.
Frankeklint (cape) -	Langeland	55 9 44	1 38 47	0 6 35 W.
Kongsberg (cape) - -	Möen -	54 58 3	0 4 12	0 0 16,75 W.
Sproe (isle) - -	Belt -	55 19 56	1 37 0	0 6 35,25 W.
Copenhagen (observatory) -	Seland -	55 41 4	0 0 0	0 0 0
Roeskilde (cathedral) -	— —	55 38 25	0 29 48	0 1 59,75 W.
Holbek (church) - -	— —	55 43 2	2 51 26	0 3 25,75 W.
Kallundborg (church) -	— —	55 40 54	1 29 12	0 5 56,75 W.
Korsör (light-house) -	— —	55 20 22	1 27 0	0 5 48 W.
Nestved (church) - -	— —	55 13 55	0 49 12	0 3 16,75 W.
Wordingborg (tower) -	— —	55 0 32	0 40 4	0 2 40,25 W.
Ringsted (church) -	— —	55 26 51	0 47 20	0 3 9,25 W.
Skagen (light-house) -	North Jutland	57 43 44	1 57 55	0 7 51,7 W.
Hiöring (church) - -	— —	57 27 44	2 35 17	0 10 21,1 W.
Fladstrand (church) -	— —	57 27 3	2 2 15	0 8 9,0 W.
Sæbye (church) - -	— —	57 20 2	2 2 36	0 8 10,5 W.
Aalborg (St. Budolph) -	— —	57 2 57	2 39 4	0 10 36,3 W.
Nibe (church) - -	— —	56 59 4	2 55 54	0 11 43,6 W.
Grenaae (church) -	— —	56 24 57	1 41 49	0 6 47,3 W.
Randers (highest steeple) -	— —	56 27 48	2 32 3	0 10 8,2 W.
Viborg (cathedral) -	— —	57 27 11	3 9 25	0 12 37,7 W.
Aarhuus (cathedral) -	— —	56 9 35	2 21 40	0 9 26,6 W.
Ribe (cathedral) -	— —	55 19 57	3 48 25	0 15 13,7 W.
Hadersleben (church) -	South Jutland	55 15 15	3 4 56	0 12 19,7 W.
Norborg (highest steeple) -	or Schleswig	55 3 53	2 49 53	0 11 19,6 W.
Apenrade (St. Nicolas) -	— —	55 2 57	3 9 7	0 12 36,9 W.
Tondern (Christ.) -	— —	54 56 30	3 41 53	0 14 47,5 W.
Sönderborg (St. Mary) -	— —	54 54 59	2 47 1	0 11 8,1 W.
Flensborg (highest steeple) -	— —	54 47 18	3 8 5	0 12 32,3 W.
Husum (church) -	— —	54 28 29	3 31 3	0 14 4,2 W.
Gluckstad (highest steeple)	Holstein -	53 47 44	3 8 43	0 12 34,8 W.
Hesselöe (isle) - -	Kattegat -	56 11 46	0 51 44	0 3 27 W.
Anholt (light-house) -	— —	56 44 20	0 55 24	0 3 41,5 W.

In all the best maps of the Kattegat, as that by Mr. LOUS, published at Copenhagen, 1790, that by M. VERDUN DE LA CRENNE, M. BORDA, and M. PINGRE', Paris, 1778, that by Mr. AKELEIE, Copenhagen, 1771, that by Mr. ANKERKRONA,

Fig. 1.

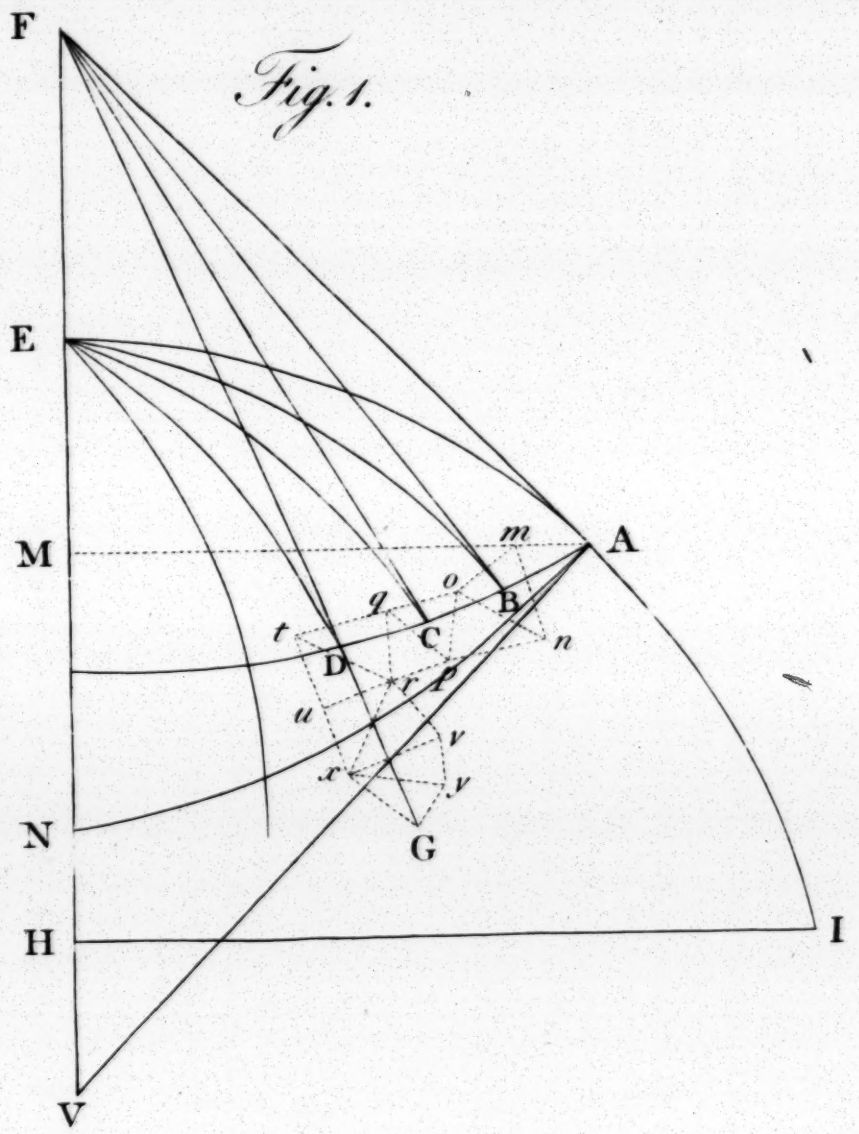
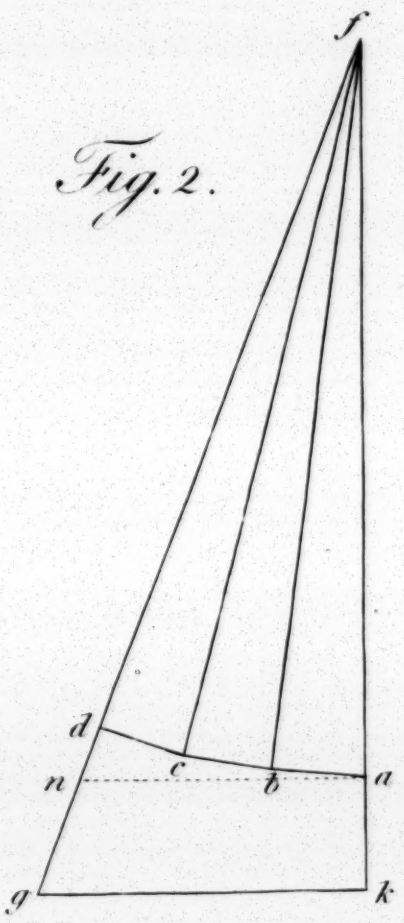


Fig. 2.



Stokholm, 1782, the position of Anholt is very erroneous. *The light-house of Anholt, and the whole isle, is from 7 to 9 minutes too much westerly; and the distance from the light-house to the Swedish coast, in a direction perpendicular to the meridian of the light-house is, in all maps hitherto published, nearly 4 English miles, or $\frac{1}{8}$th part of the whole too great.* Experience has taught the navigators, that they come too soon down upon Anholt; or that they, cruising between Anholt and Sweden, overrun their reckoning, which was ascribed to the currents; although the true reason of it was the great error in the geographical and hydrographical position of Anholt in a narrow and dangerous passage.

VIII. *On the Rotation of the Planet Saturn upon its Axis.* By William Herschel, *LL. D. F. R. S.*

Read January 23, 1794.

In a late paper on the multiplicity of the regular belts of the planet Saturn, I pointed out an analogy, which might lead us to surmise that it had a pretty quick rotation upon its axis; I can at present announce the reality of that rotation. The following series of observations, in which Saturn has been traced through one hundred and fifty-four revolutions of its equator, will sufficiently confirm it.

The changes in the belts of Jupiter, it is well known, are so frequent, that we find some difficulty to make our observations of them agree to within 3, 4, or 5 minutes of time; but the belts on Saturn, which I have been lately observing, seem to have undergone no very material change, during the course of the two last months; so that we may hope the period of the rotation of this planet, which will be assigned in this paper, may be looked upon as having a considerable degree of exactness.

Before we can enter into particulars, it will be necessary to give the series of observations upon which my computations have been founded. It is not sufficient to extract only those parts of them which have served for calculating the period; as the value of astronomical observations consists in having them entire; every circumstance, as it occurred, is of conse-

quence, and facts being stubborn things, we cannot decide upon them properly till they have been entirely laid open to our view, and sufficiently scrutinized. For this purpose the observations are all extracted from the journal, in the regular order in which they were made; and here I must remark, that I purposely avoided any calculations, or even surmises, of the length of a rotation, while the observations were making; in order to be perfectly free from every bias that might mislead the eye. In this I succeeded so well, that, when I began to calculate, I mistook not less than 4 hours and $\frac{3}{4}$ in the first supposition I made; which, happening to agree extraordinarily well with four of the most pointed observations, it misled me so far, that I was very near rejecting the whole series as inconsistent, and began to think the changes in the belts to have been so frequent, and irregular, as not to fall under any kind of calculation. It will, however, soon appear that this has not been the case, and that, on the contrary, there has been more steadiness and regularity in the belts, than might well have been expected in such kind of appearances.

OBSERVATIONS ON THE BELTS OF SATURN.*

Nov. 11, 1793. 3^h 35′. (*Correction of the clock* — 7′ 27″,1).† Seven-feet reflector; power 287; new specula, uncommonly

* A few of these observations have been lately given; but as they are essential to the series, I thought it better to repeat them here, than to refer to my former paper.

† My time is kept by one of SHELTON's clocks, set now and then by equal altitudes, taken with a 12-inch BIRD's quadrant; and checked by the passage of a set of stars over the wire of a four-feet telescope, firmly fixed to the wall of my house. By calling the correction minus, I denote, in this case, that the clock is 7′ 27″,1 too fast for true sidereal time.

distinct.* Close to the ring of Saturn, where it passes the body of the planet, is the shadow of the ring; very narrow, and black.

Immediately south of the shadow is a bright, uniform, and broad belt.

Close to this belt is a broad, darker belt, which is divided by two narrow, white streaks; so that, by this means, it becomes to be five belts; namely, three dark, and two bright ones; the colour of the dark belt is yellowish.† (A)

The space from the quintuple belt towards the south pole of the planet which is in view, is of a pale whitish colour; less bright than the white equatorial belt, and much less so than the ring.

The globular form of Saturn is very visible, so that it has, by no means, the appearance of a flat disk.

Nov. 13. $3^h\ 30'$ (*Cor.* — $7'\ 29'',5$.) The quintuple belt on Saturn is as it was Nov. 11. I saw it three hours ago, and several times since, without any visible change. (B)

Nov. 19. $3^h\ 14'$. (*Cor.* — $7'\ 36'',8$.) The southern belt of Saturn is still divided into five; the evening is not clear enough to observe changes in it, if there were any. (C)

Nov. 22. $2^h\ 32'$ (*Cor.* — $7'\ 40'',4$.) The quintuple belt on Saturn remains still the same; power 287. (D)

* In the course of these observations, I made 10 new object specula, and 14 small plain ones, for my 7-feet reflector; having already found, that with this instrument I had light sufficient to see the belts of Saturn completely well; and that, here, the maximum of distinctness might be much easier obtained, than where large apertures are concerned.

† The letters (A) (B) (C), (*a*) (*b*) (*c*), &c. as they occur, refer to calculations which will be given hereafter.

With 430, I see the same very distinctly; but the small divisions have hardly light enough, when so much magnified.

I viewed the same belt with four different object specula. One of them shewed the divisions uncommonly well.

Dec. 3. 0^h 35′. (*Cor.* — 7′ 53″,8.) The quintuple belt upon Saturn remains as it was Nov. 22. (E)

2^h 36′. 20-feet reflector; power 157; 300; 480. I see the quintuple belt very well.*

Dec. 4. 23^h 22′. (*Cor.* — 7′ 55″ *by a transit.*) 10-feet reflector. The quintuple belt is on Saturn, as it was last night. (F)

4^h 57′. 7-feet. The quintuple belt is uncommonly distinct.† The three narrow dark belts are of an equal breadth over the whole disk; the two bright belts which divide them, are also of an equal breadth throughout, but a little narrower than the dark ones. (G)

5^h 58′. I see the quintuple belt so clearly defined throughout all the 3 dark, and 2 bright belts, that I am apt to guess that the side which presents itself to me now is not the same

* I found that the strong light of this instrument was too great a fatigue for the eye, which cannot bear to look at a very luminous object for a long time together. For this reason, I chiefly used the 7-feet reflector; and in future, all the observations, not expressly marked otherwise, are to be understood as having been made with that instrument; bearing an eye-glass of 3-tenths of an inch focal length. My object specula are generally from 84 to 88 inches in focus, and, therefore, give a power from 280 to 293. The favourite one gave 287. I had another reason for chiefly confining myself to one instrument, and one power; which was, that every circumstance being as much as possible the same, a change in the object I viewed might be the sooner perceived.

† When I found the divisions between the small belts so remarkably distinct, I began to suspect that they might not be, all around the planet, perfectly uniform in brightness and figure; and therefore now described the phænomena that occurred more minutely and carefully.

which I saw in the first part of the evening; but it is not easily possible to determine whether the air might not be less clear then. I saw all other phænomena on Saturn extremely well, many times, between 1^h and 3^h; but not the belts so well as now. (H)

6^h $36'$. The belt remains as free from interruptions as it was at 5^h $58'$. (I)

6^h $52'$. I see the planet not so well defined now, as I did in the first part of the evening; being at present nearer the horizon; but I see the belts better than I did at that time. (K)

Dec. 6. 22^h $28'$ (*Cor.* — $7'$ $57''$,2.) I see the quintuple belt very distinctly. (L)

22^h $55'$. I see the quintuple belt as readily as I see the rest of the appearances on Saturn. (M) I took care to bend my head so, as to receive the picture of the belt in the same direction upon the retina, as I did December 4, at 5^h $58'$.*

23^h $55'$. I now see the quintuple belt full as well as I did Dec. 4, at 5^h $58'$. (N)

1^h $25'$. That part of the quintuple belt which is now on the meridian, or centre of Saturn, is much less separated and defined than what was there at 23^h $55'$. (O)

2^h $26'$. The divisions in the quintuple belt are not grown distincter, but rather more confused than they were before; I can scarcely perceive them. (P)

3^h $28'$. The uppermost of the small dark belts, in that part which is on the meridian, is very faint, and the most north is rather darker than before. (Q)

* This was a precaution that occurred to me, as there was a possibility that the vertical diameter of the retina might be more or less sensible than the horizontal one; but I had no reason afterwards to suppose that any such difference really exists.

4^h 28′. The most north of the two belts is darker, and a little broader than the most south. (R)

5^h 53′. Saturn is remarkably distinct; much more so than Dec. 4, at 5^h 58′; but the quintuple belt is less distinct than it was that evening; it has also undoubtedly a different appearance. The northern belt is the darkest and broadest, that next to it is less dark; and the third, or southmost belt, is faint, and hardly to be seen; the narrow white belts that separate them are contracted, and but just visible. (S)

Observation upon the double Ring of Saturn.*

The outer ring is less bright than the inner ring. The inner ring is very bright close to the dividing space; and, at about half its breadth, it begins to change colour, gradually growing fainter; and just upon the inner edge, it is almost of the colour of the dark part of the quintuple belt.

7^h 52′. This is evidently another part of the planet than what I saw in the beginning of the evening. (T)

Dec. 9. 5^h 33′. (*Cor.* — 8′ 0″,4.) The quintuple belt is extremely distinct, but not so much so, in proportion to the rest of the appearances, as I might expect. (U)

6^h 9′. The southmost dark belt is very faint; the northmost is the strongest and broadest; the bright divisions are very small, and difficult to be seen; I can, however, trace them all along. (V)

Dec. 11. 1^h 25′. (*Cor.* — 8′ 2″,6.) I see the quintuple belt. The southmost belt is extremely faint; that to the north is

* This observation is foreign to the present purpose, but as it is new, and but short, I would not omit it; and for the same reason, two or three more are retained hereafter.

the darkest and broadest; the middlemost is nearly as dark, but not quite so broad. (W) The air is much disturbed by wind, and flying haziness.

5^h 5′. The quintuple belt is very distinct. The southmost belt is less faint than it was at 1^h 25′; but the wind is too high, and the air too disturbed, to examine it minutely. (X)

Dec. 13. 23^h 40′. (*Cor.* — 8′ 4″,7.) I see the divisions of the quintuple belt very well; but there is a dry wind, and the telescope will not shew objects with that degree of distinctness which it usually does, when moisture is discharged from the air, by the precipitation of dew. (Y)

0^h 46′. I see the quintuple belt very well.

REMARK ON THE SHADOWS OF SATURN AND ITS RING.

On the south following part of the ring, close to the body of the planet, is the shadow of the body.

The shadow of the ring upon the body of the planet close to the ring, is not parallel to the ring at the two extremes, but a little broader there, than in the middle; the ends turning towards the south.

2^h 4′. The bright divisions between the belts are very narrow. The southmost dark belt is not much less faint than the northmost. (Z)

2^h 51′. The southmost dark belt on the preceding side, which at 23^h 40′, I thought was a little more south than the inside of the ring, now falls short of it. The broad bright belt also seems to be narrower now, than it was at that time.*

* Suspecting that the situation and direction of the belts might not be uniform all around the planet, I began to be more careful in describing the particulars relating to those circumstances; but found, soon after, that no additional light could be gathered from an attention to them.

3^h 2′. The broad bright belt, is as broad as the next three belts and a half, of the quintuple belt: that is, not quite so broad as the quintuple belt, without the southmost narrow dark belt.

4^h 11′. The broad white belt is of the breadth of the three adjoining belts.

5^h 11′. Appearances seem to be the same as they were an hour ago. The evening is indifferent. (*a*)

Dec. 16. 0^h 43′. (*Cor.* — 8′ 8″,0 *by a transit.*) I see the quintuple belt extremely well.

1^h 3′. The most south of the three dark belts, is full up to the inner edge of the preceding side of the ring; or rather a little above (or south of) it. The following side is less south, with regard to the ring, than the preceding; so that the quintuple belt is not parallel with that part of the ring, which crosses the body.

2^h 21′. The southmost belt is very faint; the middle and northern ones are much darker, and seem to be broader and closer, than I have at other times seen them. (*b*)

With 215. This power is too small to distinguish the divisions of the quintuple belt sufficiently.

3^h 12′. There seems to be no material alteration, but I do not see the divisions of the belt so distinctly as from the appearance of the other phænomena I ought to do. (*c*)

4^h 5′. The southmost belt meets the inner edge of the preceding part of the ring very nearly, and the quintuple belt seems to be parallel to the northern part of the ring, or nearly so.

4^h 16′. 10-feet reflector; power 300. The quintuple belt is parallel to the northern part of the ring, which is turned towards us.

5^h 35′. 7-feet. The southmost belt is brighter than it was at 2^h 21′. (*d*)

Dec. 18. 23^h 54′. (*Cor.* — 8′ 9″,8.) I see the quintuple belt. (*e*)

1^h 19′. All the parts of the quintuple belt seem to be very uniform. The southmost on the preceding side, reaches full up to the ring, where it passes behind the body. (*f*)

I viewed the planet with eight different object specula, they all shewed the quintuple belt very well.

Dec. 19. 1^h 41′. (*Cor.* — 8′ 10″,6.) I have a very beautiful view of Saturn. I should suppose this part of Saturn to be that, where the quintuple belt is not so distinct as it is on some other parts; though I see it very well; yet from the extraordinary distinctness of the other phænomena, I think I ought to see it still better. (*g*)

THE FIVE OLD SATELLITES.

1^h 56′. 10-*feet reflector*; *with a power of* 60 *only, I see all the five old satellites.**

4^h 15′. 7-feet reflector. The southmost belt is faint The quintuple belt is a little broader on the preceding side, than on the following. (*h*)

Dec. 23. 3^h 46′. (*Cor.* — 8′ 14″,2.) I see the quintuple belt very distinctly. The northmost of the dark belts is the broadest and darkest; the southmost is very faint; they are parallel to the ring, and the southmost just comes up to the inner edge of the ring. (*i*)

* This observation was made to try with how low a power they might be seen.

Dec. 29. 1^h 10′. (*Cor.* — 8′ 19″,5.) The quintuple belt remains on Saturn as it used to be; the southmost of the dark belts is faint. (*k*)

Jan. 1, 1794. 2^h 2′. (*Cor.* — 8′ 22″,1.) I see the quintuple belt very well; the southmost belt is not much fainter than the northmost. (*l*)

Observations of the South Pole of Saturn, and the Shadow of the Ring.

3^h 40′. *The south polar regions of Saturn, are a little brighter in proportion to the bright equatorial belt, than they used to be; they are almost as bright as that belt.*

The shadow of the ring upon Saturn is perfectly black, like the shadow of Saturn upon the ring. The shadow of the ring upon Saturn, on each side, is bent a little southwards; so that the apparent curve it makes departs a little from the ring.

5^h 18′. The three dark belts of the quintuple belt seem to be very close, but the air is tremulous; I can however see them divided. (*m*)

Jan. 2. 23^h 53′. (*Cor.* — 8′ 23″,0 *by a transit.*) The quintuple belt is very distinct. The southmost belt is almost as dark as the other two. (*n*)

1^h 52′. The southmost belt is very nearly, if not quite as dark and distinct as the northmost. The air is very fine, and all the phænomena on Saturn are beautifully distinct. (*o*)

Jan. 4. 1^h 36′. (*Cor.* — 8′ 23″,8.) The quintuple belt is not so distinct as, from the appearance of the rest of the phænomena on Saturn, one might expect to see it. All the three dark belts are fainter than I have often seen them; and the southmost of them is much fainter than the northmost. (*p*)

2^h 35′. The quintuple belt is still faint. The southmost belt much fainter than the northmost; the latter is not only stronger, but also broader than the former. (*q*)

Jan. 7. 1^h 4′. (*Cor.* — 8′ 25″,0 *by a transit.*) The three dark belts of the quintuple belt, seem not to differ much in colour and breadth, but the evening is very indifferent. (*r*)

1^h 53′. The air is a little clearer. The southmost is very little (if at all) less dark than the northmost; they are all very faint. (*s*)

3^h 18′. As well as the night will permit to see, I judge the dark belts to be pretty equal in colour and size, the northmost, however, is still a little darker, and broader than the other two. (*t*)

3^h 44′. The dark belts seem to be as equal as I have seen them at any time. I see them very well. (*u*)

TRIAL OF CONCAVE EYE GLASSES.

I tried five new concave eye glasses, but they all proved defective in figure; with one of them, power 360, *I saw the quintuple belt pretty well. With regard to the field of view they are full as convenient as convex glasses.* (*v*)

5^h 50′. The three dark belts are still nearly alike, and uniformly divided by the bright ones. (*w*)

Jan. 16. 2^h 52′. (*Cor.* — 8′ 28″,6.) I suppose this to be the part of the quintuple belt, which is nearly uniform; the southmost one however is not quite so dark as the northmost. (*x*)

4^h 20′. The belts seem to be equal and uniform throughout. (*y*)

5^h 5′. The belts seem to be uniform; the southmost however is the faintest. (*z*)

Determination of the Period.

I shall now enter upon the method, which has been used to determine the rotation of the planet, from these observations.

Let K, T, Z, P, in the annexed figure, (see Tab. IX.) represent the quintuple belt on the southern hemisphere of Saturn; the different parts of which are diversified as expressed by the different tints of the belts: those at E A K N I H M L G being uniform, while others at T B C D V, and R Q Y F have the southmost of the small dark belts very faint, and the northmost pretty strongly marked. Let α be the south pole of Saturn, and let the circle 90, 180, 270, 360 represent its equator, divided into degrees; so that α 180, α 210, α 240, α 270, &c. are meridians of Saturn, which, as the planet turns upon its axis, from west to east, will successively pass over the line $\alpha\ \beta\ \gamma$, representing that meridian on Saturn which passes through the earth.

Then the eye of the observer being placed in the line $\alpha\ \beta\ \gamma$, at a great distance, and the hemisphere of Saturn, which is here projected on the plane of the equator, being in an oblique position, will only see the semicircle $\delta\ \beta\ \varepsilon$. But on account of the great inclination of the arches $\zeta\ \delta$, $\eta\ \varepsilon$, to the visual ray $\gamma\ \beta\ \alpha$, the eye will not perceive minute divisions, or marks, till they come within the limits $\zeta\ \eta$, and even then will no where judge so well of their brightness and figure as when they draw near the situation β.

The divisions on the equator, are to serve us to point out those places of the quintuple belt, which, by future calculations of the motion of this equator, will be shewn to have been on the meridian, $\alpha\ \beta\ \gamma$, at any given time; and the numbers

are placed in the reverse order of the rotation, that the calculated motion of the belt may immediately point out the place which is come to the meridian. Thus, if the point K at 180 has moved 53 degrees forward, the situation x, on the belt, may be concluded to be on the meridian; because it is at 180 + 53, that is, the 233d degree.

Assuming for an epoch the observation of Dec. 4. 4^h 57′, where the different small belts, that make up the quintuple belt, are described as quite uniform; let it be placed at the 180th degree of the divided circle, where it will be fully exposed to the view of the observer.

I now select a few observations that are strongly marked, and as far distant from each other as can be found, by way of trying in what rotation they will agree. Such are the following two: Dec. 4. 6^h 52′; Jan. 7. 3^h 44′, for the places where the belts were uniform; and other two, Dec. 6. 7^h 52′, Jan. 4. 2^h 35′, for places where they appeared unequal. The sidereal times being corrected, and brought to true mean time, we have from Dec. 4. 13^h 46′ 51″, to Jan. 7. 8^h 25′ 11″ an interval of 33 days 18^h 38′ 20″; in which time let us suppose 79 revolutions to have been made. This will give 10^h 15′ 40″ for the time of each revolution.

In the next place, we have from Dec. 6. 14^h 38′ 47″ to Jan. 4. 7^h 28′ 12″ an interval of 28 days 16^h 49′ 25″; and allotting 67 revolutions to this, we obtain 10^h 16′ 51″ for the time of the rotation. These periods being independent of each other, and the observations having been made upon different parts of the belt, agree very well together. But now, some intermediate places are wanted, by way of trying, whether the period thus determined will accord with the rest of the observations; and

for this purpose I select Dec. 18. 1^h 19′, Jan. 2. 1^h 52′; and bringing them also to true mean time, we have,

From Dec. 4. 13^h 46′ 51″ to Dec. 18. 7^h 19′ 28″ an interval of 13 days 17^h 32′ 37″. Then, supposing 32 revolutions to have been made, we obtain a period of 10^h 17′ 54″. Also,

From Dec. 4. 13^h 46′ 51″ to Jan. 2. 6^h 53′ 11″ is an interval of 28 days 17^h 6′ 20″; and admitting 67 revolutions of the belts, the period will be 10^h 17′ 6″.

These trials of intermediate times agreeing with the former sufficiently well, there can remain no doubt about the true quantity of the period in general. I therefore take a mean of the two first determinations, which gives 10^h 16′ 15″,5 for the approximate rotation of Saturn upon its axis.

It now becomes necessary to construct tables for a general calculation of all the observations. For, if these should contain descriptions contradicting the calculated appearances of the quintuple belt, our assigned period could not be looked upon as sufficiently established; on the contrary, if the calculated and observed appearances are found to agree, we may rest satisfied that the rotatory motion of this planet, which has so long eluded our strictest attention, is at length obtained.

In consequence of a few trials, which were made after the 7th of January, by tables constructed upon this mean period, I found that some small correction was required; and obtaining another very good observation on the 16th of the same month, it gave me an interval which included one hundred revolutions of the equator of Saturn. Now, making the proper deduction for the planet's retrograde motion during the time that passed between the first and last observation, we have from Dec. 4. 13^h 46′ 51″ to Jan. 16. 8^h 25′ 39″ an interval of 42 days

18^h 38′ 48″ in which the equator of Saturn moved over 35998,87 degrees, from which we compute a period of 10^h 16′ 0″,44.

The following tables have been constructed upon this last period, and in the use of them the complement of the geocentric longitude of Saturn is always to be added, as has been explained in the tables of the satellites of that planet. Phil. Trans. Vol. LXXX. part II. page 495.

TABLES FOR THE EQUATORIAL MOTION OF SATURN.		
Epochs of the Longitude of the uniform Part of the Belts.		
1793 November	-	284°,18
1793 December	-	330 ,62
1794 January	-	138 ,61.

Motion of the Equator of Saturn, in Days, Hours, Minutes, and Seconds.

Days.	Deg. dec.	Hours	Deg. dec.	Min.	Deg.dec.	Min.	Deg.dec.	Sec.	dec.	Sec.	dec.
1	121,55	1	35,06	1	,58	31	18,12	1	,01	31	,30
2	243,10	2	70,13	2	1,17	32	18,70	2	,02	32	,31
3	4,64	3	105,19	3	1,75	33	19,29	3	,03	33	,32
4	126,19	4	140,26	4	2,34	34	19,87	4	,04	34	,33
5	247,74	5	175,32	5	2,92	35	20,45	5	,05	35	,34
6	9,29	6	210,39	6	3,51	36	21,04	6	,06	36	,35
7	130,84	7	245,45	7	4,09	37	21,62	7	,07	37	,36
8	252,38	8	280,52	8	4,68	38	22,21	8	,08	38	,37
9	13,93	9	315,58	9	5,26	39	22,79	9	,09	39	,38
10	135,48	10	350,65	10	5,84	40	23,38	10	,10	40	,39
11	257,03	11	25,71	11	6,43	41	23,96	11	,11	41	,40
12	18,58	12	60,77	12	7,01	42	24,54	12	,12	42	,41
13	140,12	13	95,84	13	7,60	43	25,13	13	,13	43	,42
14	261,67	14	130,90	14	8,18	44	25,71	14	,14	44	,43
15	23,22	15	165,97	15	8,77	45	26,30	15	,15	45	,44
16	144,77	16	201,03	16	9,35	46	26,88	16	,16	46	,45
17	266,32	17	236,10	17	9,93	47	27,47	17	,16	47	,46
18	27,86	18	271,16	18	10,52	48	28,05	18	,17	48	,47
19	149,41	19	306,23	19	11,10	49	28,64	19	,18	49	,48
20	270,96	20	341,29	20	11,69	50	29,22	20	,19	50	,49
21	32,51	21	16,35	21	12,27	51	29,80	21	,20	51	,49
22	154,06	22	51,42	22	12,86	52	30,39	22	,21	52	,50
23	275,60	23	86,48	23	13,44	53	30,97	23	,22	53	,51
24	37,15	24	121,55	24	14,03	54	31,56	24	,23	54	,52
25	158,70			25	14,61	55	32,14	25	,24	55	,53
26	280,25			26	15,19	56	32,73	26	,25	56	,54
27	41,80			27	15,78	57	33,31	27	,26	57	,55
28	163,34			28	16,36	58	33,90	28	,27	58	,56
29	284,89			29	16,95	59	34,48	29	,28	59	,57
30	46,44			30	17,53	60	35,06	30	,29	60	,58
31	167,99										

The following 50 positions have been calculated by the above tables, and belong to the several observations which are marked with the tabular letters of references, as has been explained in the 2d note, page 50. They have been computed to two places of decimals, but are only put down in degrees, as being sufficiently near for comparing them with the descriptions belonging to those parts of the belt which they point out.

Table of calculated Positions.

A	201	K	180	T	94	*c*	43	*m*	225	*v*	186
B	77	L	125	U	10	*d*	127	*n*	155	*w*	239
C	63	M	141	V	31	*e*	167	*o*	224	*x*	129
D	37	N	176	W	105	*f*	216	*p*	93	*y*	180
E	201	O	228	X	233	*g*	348	*q*	128	*z*	206
F	278	P	264	Y	282	*h*	78	*r*	73		
G	113	Q	300	Z	6	*i*	178	*s*	101		
H	149	R	335	*a*	115	*k*	83	*t*	151		
I	171	S	24	*b*	14	*l*	111	*u*	166		

I may venture to say, that there are not many of these calculated observations which do not very forcibly concur in proving the assigned revolution to be properly stated. I shall however only mention a few of the leading ones, and leave the rest to be looked over at leisure by those who wish to examine the subject minutely.

In observations previous to the 4th of December, no particular attention had been given to the minutiæ of the belts; but we may suppose them, on the 11th of November, to have been considerably distinct and uniform, to occasion their being noticed; and this the calculation verifies. For the position A points out 201 degrees, as the situation which was on the

meridian at the time of observation, and by the figure we find it to be a very marked place.

A strong evidence of the rotation is the position H 149, observed Dec. 4, contrasted with the place F 278, which had been viewed in the early part of the same evening. The calculation here completely supports the suspicion which is expressed in the observation, " that the side which presented " itself then was not the same which had been seen in the be- " ginning of the evening."

The observations of Dec. 6, are of the most decisive nature; as will clearly appear by viewing the calculated positions L M N O P Q R S T, and comparing them with the descriptions belonging to them, that have been given in the observations. For, here the revolving belts were successively seen, in all their various tints, and the last position T was marked down as leaving no doubt of the evident rotation. By the calculation it appears that the belts had moved over 329 degrees, in the course of this evening's observation.

When the positions *c*, *d*, are compared, which were observed Dec. 16, we see that the southmost belt had acquired an additional brightness, as the observation expresses. It may not be amiss to remark upon this occasion, that brightness relates to clearness, distinctness, and easiness of vision; in opposition to faintness and confused outlines; therefore, the belt being brighter here, denotes its being more strongly marked by a deeper tint of dusky yellow, and by clearer divisions; so as to be easier perceived.

Dec. 19 furnishes a good instance of the exactness of our period; as the calculated position *g* perfectly justifies the surmise which is expressed in the observation.

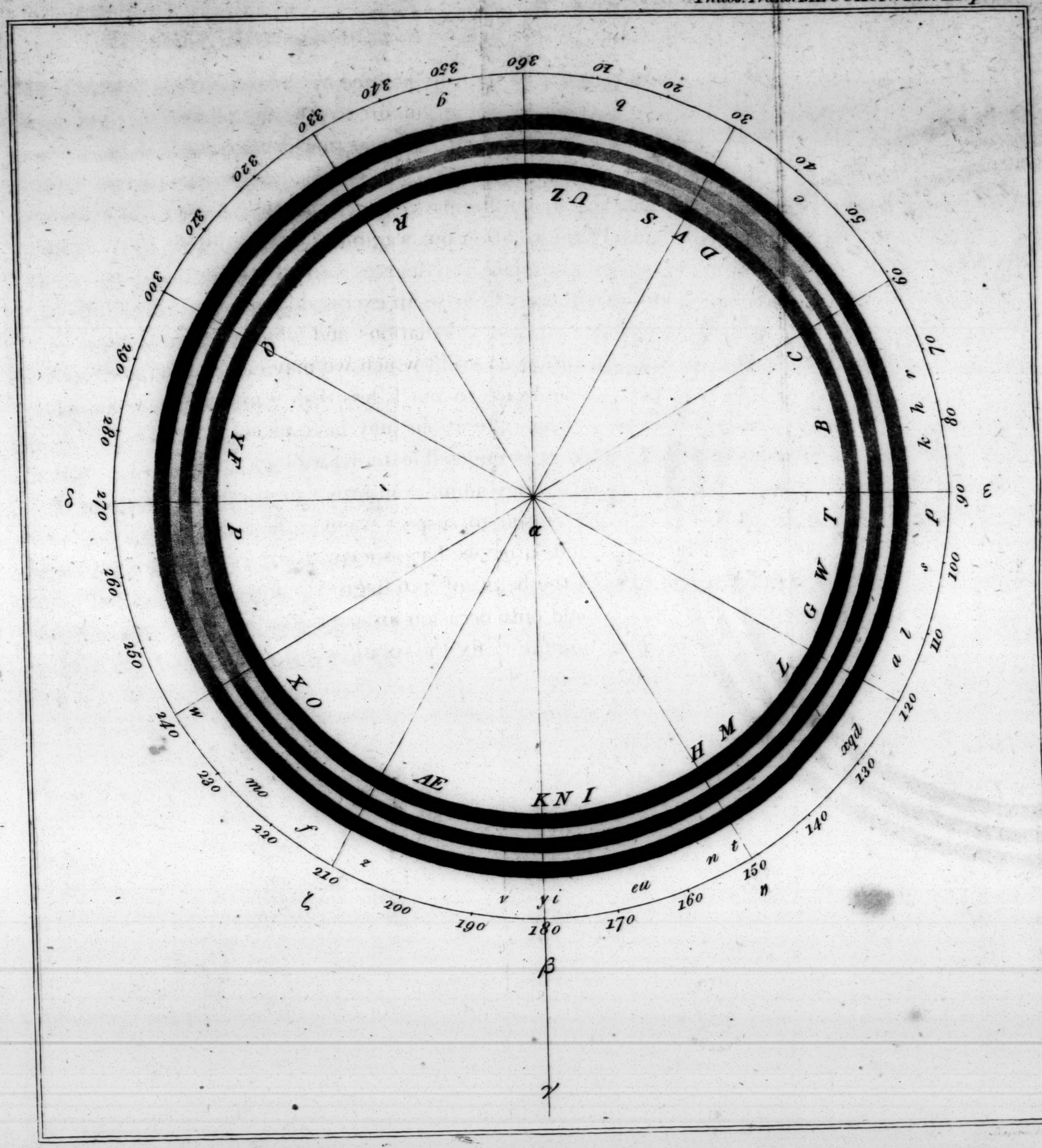
Last of all, the place *y*, being truly pointed out by computation for Jan. 16, after a series of an hundred revolutions since the 4th of December, must concur in supporting our assigned period.

I shall only add one general remark, which is, that if we lengthen the time of the rotation but 2 minutes, it will throw the last observation back above 116 degrees; and if we diminish it by 2 minutes, there will arise an excess of more than 117; and, in either case, the calculations and observations would be totally at variance: from which we may conclude that our period must be exact to much less than 2 minutes, either way. Indeed, what alterations may have taken place in the belts themselves, it is impossible to determine. That there have been some, we may admit, and rather suppose, but we have no particular reason to suspect them to have been very considerable. And, after we have shewn that a proper motion, in the spots of the belts, of 116 degrees one way, or of 117 the other, would only occasion an error of 2 minutes in time, we need not hesitate to fix the rotation of the planet Saturn upon its axis at $10^h\ 16'\ 0'',4$.

Slough, near Windsor,
Jan. 22, 1794.

WM. HERSCHEL.

Erratum. Phil. Trans. for 1793. Part II. page 215. 2d line, for *more than two degrees and a third*, read $1°\ 11'\ 47'',6$.


360
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IX. *An Account of a Method of measuring the comparative Intensities of the Light emitted by luminous Bodies. By Lieutenant-General Sir* Benjamin Thompson, *Count of* Rumford, *F. R. S. In two Letters to Sir* Joseph Banks, *Bart. P. R. S.*

Read February 6, 1794.

Letter I.

DEAR SIR,

About two years ago, being employed in making a number of experiments to determine, if possible, the most œconomical method of lighting up a very large workhouse, or public manufactory, which has been erected in the suburbs of this city under my directions, where the poor, old and young, and all industrious people who are in want of work, are employed in a great variety of different manufactures, a method occurred to me for measuring the relative quantities of light emitted by lamps of different constructions, candles, &c. which is very simple, and which I have reason to think perfectly accurate. I sent you a verbal account of this little invention about a year and a half ago, by Dr. Baader, who wrote to me that you seemed to be pleased with it; but, as I think it very probable, that he might not have been able to give you a complete idea of the matter from memory, I have determined to send you a short account of it in writing, which, if you should think it worthy of that honour, you will be pleased to lay before the Royal Society. The method is shortly this:—

Let the two burning candles, lamps, or other lights to be compared, A and B, be placed at equal heights upon two light tables, or moveable stands, in a darkened room; let a sheet of clean white paper be equally spread out, and fastened upon the wainscot or side of the room, at the same height from the floor with the lights, and let the lights be placed over against this sheet of paper, at the distance of 6 or 8 feet from it, and 6 or 8 feet from each other, in such a manner, that a line drawn from the centre of the paper, perpendicular to its surface, shall bisect the angle formed by lines drawn from the lights to that centre; in which case, considering the sheet of paper as a plane speculum, the one light will be precisely in the line of reflection of the other.

This may be easily performed, by actually placing a piece of a looking-glass, 6 or 8 inches square, flat upon the paper, in the middle of it, and observing by means of it the real lines of reflection of the lights from that plane, removing it afterwards as soon as the lights are properly arranged.

When this is done, a small cylinder of wood, about $\frac{1}{4}$ of an inch in diameter, and 6 inches long, must be held in a vertical position about 2 or 3 inches before the centre of the sheet of paper, and in such a manner, that the two shadows of the cylinder corresponding to the two lights may be distinctly seen upon the paper.

If these shadows should be found to be of unequal densities, which will almost always be the case, then that light whose corresponding shadow is the densest, must be removed farther off, or the other must be brought nearer to the paper, till the densities of the shadows appear to be exactly equal; or in other words, till the densities of the rays from the two lights are

equal *at the surface of the paper*; when, the distances of the lights from the centre of the paper being measured, the squares of those distances will be to each other as the real intensities of the lights in question at their sources.

If, for example, the weaker light being placed at the distance of 4 feet from the centre of the paper, it should be found necessary, in order that the shadows may be of the same density, to remove the stronger light to the distance of 8 feet from that centre, in that case, the real intensity of the stronger light will be to that of the weaker as 8^2 to 4^2; or as 64 to 16; or 4 to 1; and so for any other distances.

It is well known, that any quality proceeding from a centre in straight lines in all directions, like the light emitted by a luminous body, its intensity at any given distance from that centre will be as the square of that distance inversely; and hence it is clear, that the intensities of the lights in question at their sources, must be to each other as the squares of their distances from that given point *where their rays uniting are found to be of equal density.* For putting $x =$ the intensity of B; if P represents the point where the rays from A and from B meeting are found to be of equal density or strength, and if the distance of A from P be $= m$, and the distance of B from the same point P $= n$; then, as the intensity of the light of A at P is $= \frac{x}{m^2}$, and the intensity of the light of B at the same place $= \frac{y}{n^2}$, and as it is $\frac{x}{m^2} = \frac{y}{n^2}$ by the supposition, it will be $x : y :: m^2 : n^2$.

That the shadows being of equal density at any given point, the intensities of the illuminating rays must of necessity be equal at that point also, is evident from hence, that the total absence of light being perfect blackness, and the shadow cor-

responding to one of the lights in question being deeper or fainter, according as it is more or less enlightened by the other, when the shadows are equal, the intensities of the illuminating rays must be equal likewise.

In removing the lights, in order to bring the shadows to be of the same density, care must be taken to recede from, or advance towards the centre of the paper in a straight line, so that the one light may always be found exactly in the line of reflection of the other; otherwise the rays from the different lights falling upon the paper, and consequently upon the shadows, at different angles, will render the experiment fallacious.

When the intensity of one strong light is compared with the intensities of several smaller lights taken together, the smaller lights should be placed in a line perpendicular to a line drawn to the centre of the paper, and as near to each other as possible; and it is likewise necessary to place them at a greater distance from the paper than when only single lights are compared.

In all cases, it is absolutely necessary to take the greatest care that the lights compared be properly trimmed, and that they burn clear, and equally, otherwise the results of the experiments will be extremely irregular and inconclusive. It is astonishing what a difference there is in the quantities of light emitted by the same candle, when it burns with its greatest brilliancy, and when it has grown dim for want of snuffing. But as this diminution of light is progressive, and as the eye insensibly conforms to the quantity of light actually present, it is not always taken notice of by the spectators;—it is nevertheless very considerable, in fact, as will be apparent to any one who will take the trouble to make the experiment; and

so great is the fluctuation in the quantity of light emitted by burning bodies, lamps, or candles, in all cases, even under the most favourable circumstances, that this is the source of the greatest difficulties I have met with in determining the relative intensities of lights by the method here proposed.

To ascertain by this method the comparative densities, or intensities of the light of the moon, and of that of a candle, the moon's direct rays must be received upon a plane white surface, at an angle of incidence of about 60°, and the candle placed in the line of the reflection of the moon's rays from this surface; when the shadows of the cylinder corresponding to the moon's light, and to that of the candle, being brought to be of equal density, by removing the candle farther off, or bringing it nearer to the centre of the white plane, as the occasion may require, the intensity of the moon's light will be equal to that of the candle *at the given distance of the candle from the plane.*

To ascertain the intensity of the light of the heavens by day or by night, this light must be let into a darkened room through a long tube, blackened on the inside, when its intensity may be compared with that of a candle or lamp by the method above described.

To determine the intensity of the direct rays of the sun, compared to the light emitted by any of our artificial illuminators, it may perhaps be necessary, considering the almost inconceivable intensity of the sun's light, to make use of some further contrivances and precautions, but I am convinced, however, that it may be done, and that even with a very considerable degree of precision. And when the relative intensity of the sun's light at the surface of the earth, compared

with the intensity of the light of a given lamp, placed at a given distance, and burning with a flame of given dimensions, shall be known; it will then be easy, from the known size and distance of the sun, to compute the relative density of his light at *his* surface, compared to the density of the light of the flame of the lamp at the surface of that flame.

The intensity of the light emitted in the combustion of iron or of phosphorus in dephlogisticated air, as also that of all other burning, or red-hot bodies, may be compared and determined by this method with the greatest facility and exactness.

In my next letter I shall endeavour to give you an account of the result of my inquiries with respect to the best and most œconomical method of producing light by candles, lamps, &c. for common use; together with a comparative view of the expence of lights of various kinds, the *quantity* of light produced remaining the same; with such further remarks and observations as may occur.

Munich,
20th December, 1792.

I am, &c.

LETTER II.

DEAR SIR,

Since my letter of the 20th December last I have made many improvements in the apparatus contrived for measuring the intensity of light, and I have now brought the principal instrument to such a degree of perfection, that, if I might without being suspected of affectation, I should dignify it with

a name, and call it a *photometer*. I have likewise made a considerable number of new experiments; but before I proceed to give an account of them, it will be necessary to describe very particularly the alterations I have found it expedient to make in the instruments.

And, in the first place, the shadows, instead of being thrown upon a paper spread out upon the wainscot, or side of the room, are now projected upon the inside of the back part of a wooden box, $7\frac{1}{4}$ inches wide, $10\frac{1}{2}$ inches long, and $3\frac{1}{4}$ inches deep, in the clear, open in front to receive the light, and painted black on the inside, in every part except the back, upon which the white paper is fastened which receives the shadows. To the under part of the box is fitted a ball and socket, by which it is attached to a stand which supports it; and the top or lid of it is fitted with hinges, in order that the box may be laid quite open as often as it is necessary to alter any part of the machinery it contains. The front of the box is likewise furnished with a falling lid or door, moveable upon hinges, by which the box is closed in front when it is not in actual use.

Finding it very inconvenient to compare two shadows projected by the same cylinder, as these were either necessarily too far from each other to be compared with certainty, or when they were nearer they were in part hid from the eye by the cylinder, to remedy this inconvenience, I now make use of two cylinders; which being fixed perpendicularly in the bottom of the box just described, in a line parallel to the back part of it, distant from this back $2\frac{2}{10}$ inches, and from each other 3 inches, measuring from the centres of the cylinders; when the two lights made use of in the experiment are properly placed,

these two cylinders project four shadows upon the white paper upon the inside of the back part of the box, which I shall henceforth call *the field* of the instrument, two of which shadows are in contact precisely in the middle of that field, and it is these two alone that are to be attended to. To prevent the attention being distracted by the presence of unnecessary objects, the two outside shadows are made to disappear, which is done by rendering the field of the instrument so narrow, that they fall without it upon a blackened surface, upon which they are not visible. If the cylinders be each $\frac{4}{10}$ of an inch in diameter, and $2\frac{2}{10}$ inches in height, as in the instrument I have lately constructed, it will be quite sufficient, if the field be $2\frac{7}{10}$ inches wide; and as an unnecessary height of the field is not only useless, but disadvantageous, as a large surface of white paper not covered by the shadows produces too strong a glare of light, the field ought not to be more than $\frac{3}{10}$ of an inch higher than the tops of the cylinders.

In order to be able to place the lights with facility and precision, a fine black line is drawn through the middle of the field from the top to the bottom of it, and another (horizontal) line at right angles to it, at the height of the top of the cylinders. When the tops of the shadows touch this last-mentioned line, the lights are at a proper height; and when further, the two shadows are in contact with each other in the middle of the field, the lights are then in their proper directions.

In my new-improved instrument (for I have already caused four to be constructed) the white paper which forms the field is not fastened immediately upon the inside of the back of the box, but it is pasted upon a small pane of very fine ground glass, and this glass, thus covered, is let down into a groove

made to receive it in the back of the box. This covered glass is $5\frac{1}{2}$ inches long, and as wide as the box is deep, viz. $3\frac{1}{4}$ inches, but the field of the instrument is reduced to its proper size by a screen of black pasteboard interposed before the anterior surface of this covered glass, and resting immediately upon it. A hole in this pasteboard, in the form of an oblong square, $1\frac{7}{10}$ inches wide, and two inches high, determines the dimensions, and forms the boundaries of the field. This screen should be large enough to cover the whole inside of the back of the box, and it may be fixed in its place by means of grooves in the sides of the box, into which it may be made to enter. The position of the opening above mentioned is determined by the height of the cylinders, the top of it being $\frac{3}{10}$ of an inch higher than the tops of the cylinders; and as the height of it is only two inches, while the height of the cylinders is $2\frac{2}{10}$ inches, it is evident that the shadows of the lower parts of the cylinders do not enter the field. No inconvenience arises from that circumstance; on the contrary, several advantages are derived from that arrangement.

Instead of the screen just described, I sometimes make use of another, which differs from it only in this, that the hole in it, which determines the form and dimensions of the field, instead of being quadrangular, is round, and $1\frac{6}{10}$ inches in diameter. And when this screen is made use of, the shadows are increased in width (by means which will hereafter be described), in such a manner as completely to fill the field, appearing under the form of two hemispheres, or rather half disks, touching each other in a vertical line. The object I had in view in reducing the field and the shadows to a circular form was this; I imagined that by diminishing the number

of objects capable of acting upon the mind, and particularly by removing all straight lines and angles, and all unnecessary varieties of lights and shades, the attention might be concentrated and fixed in such a manner as to render the sense of sight peculiarly acute in distinguishing any difference in the simple objects presented to the eye. But however plausible this reasoning may appear, I own the experiment did not answer my expectation. It is true, the apparent densities of two equal hemispheres of shade, in contact with each other, may be compared with great facility, and when no discernible difference is to be perceived between them, it is more than probable that they are in fact very nearly equal; but still I have found by experience, that two equal parallelograms of shade in contact with each other may be compared with the same ease, and, I have reason to think, with equal certainty, and *that* even when these united shadows are bounded on three sides by a perfectly white surface, illuminated by the direct rays of two strong lights; that is to say, when the screen with the quadrangular opening or field is made use of.

In describing the cylinders by which the shadows are projected, I said they were fixed in the bottom of the box; but as the diameters of the shadows of the cylinders vary in some small degree, in proportion as the lights are broader or narrower, and as they are brought nearer to or removed farther from the photometer, in order to be able in all cases to bring these shadows to be of the same diameter, which I have found by experience to be advantageous, in order to judge with greater facility and certainty when the shadows are of the same density, I have rendered the cylinders moveable about their axes, and have added to each a vertical wing $\frac{1}{20}$ of an inch wide, $\frac{1}{16}$ of

an inch thick, and of equal height with the cylinder itself, and firmly fixed to it from the top to the bottom. This wing commonly lies in the middle of the shadow of the cylinder, and as long as it remains in that situation it has no effect whatever; but when it is necessary that the diameter of one of the shadows be increased, the corresponding cylinder is moved about its axis, till the wing just described emerging out of the shadow, and intercepting a portion of light, brings the shadow projected upon the field of the instrument to be of the width or diameter required. In this operation it is always necessary to turn the cylinder outwards, or in such a manner that the augmentation of the width of the shadow may take place on that side of it which is opposite to the shadow corresponding to the other light. The necessity for that precaution will appear evident to any one who has a just idea of the instrument in question, and of the manner of making use of it.

It is by means of these wings attached to the cylinders that the widths of the shadows are augmented, so as to fill the whole field of the *photometer*, when the screen with the circular opening is made use of.

As the lower ends of the cylinders which pass through the holes made to receive them in the bottom of the box are about $\frac{1}{20}$ of an inch less in diameter than their upper parts, which cast the shadows, and as they not only go quite through the bottom of the box (which is an inch thick) but project near an inch below its inferior surface, and, lastly, as these cylinders are not firmly fixed in these holes, it is easy, by taking hold of the ends of them which project below the bottom of the box, to turn about the cylinders upon their axes, even without

opening the box. I said above, that the height of the vertical wing attached to each of the cylinders was equal to the height of the cylinder itself:—this must be understood to mean, not the total length of the cylinder, comprehending that part of it which passes into, and through the bottom of the box; but merely its height above the bottom of the box, or part projecting, namely $2\frac{2}{10}$ inches.

As it is absolutely necessary that the cylinders should constantly remain precisely perpendicular to the bottom of the box, or parallel to each other, it will be best to construct them of brass, and instead of fixing them immediately to the bottom of the box (which being of wood may warp), to fix them to a strong, thick piece of well hammered plate brass, which plate of brass may be afterwards fastened to the bottom of the box by means of one strong screw. In this manner two of my best instruments are constructed. And, in order to secure the cylinders still more firmly in their vertical positions, they are furnished with broad flat rings, or projections, where they rest upon the brass plate; which rings are $\frac{1}{10}$ of an inch thick, and equal in diameter to the projection of the wing of the cylinder, to the bottom of which they afford a firm support. These cylinders are likewise forcibly pushed, or rather pulled against the brass plate upon which they rest, by means of compressed spiral springs, placed between the under side of that plate and the lower ends of the cylinders.

Of whatever material the cylinders be constructed, and whatever be their forms or dimensions, it is absolutely necessary that they, as well as every other part of the photometer, except the field, should be well painted of a deep black, dead colour. That will prevent the inconveniences which would

otherwise arise from reflected light, and from the presence of too great a number of visible objects.

In order to move the lights to and from the photometer with greater ease and precision, I have provided two long and narrow, but very strong and steady tables, in the middle of each of which there is a straight groove, in which a sliding carriage, upon which the light is placed, is drawn along by means of a cord which is fastened to it before and behind, and which passing over pullies at each end of the table, goes round a cylinder, which cylinder is furnished with a winch, and is so placed near the end of the table adjoining the photometer, that the observer can turn it about, without taking his eye from the field of the instrument.

Many advantages are derived from this arrangement; as first, the observer can move the lights as he finds necessary, without the help of an assistant, and even without removing his eye from the shadows; secondly, each light is always precisely in the line of direction in which it ought to be, in order that the shadows may be in contact in the middle of the vertical plane of the photometer; and thirdly, the sliding motion of the lights being perfectly soft and gentle, that motion produces little or no effect upon the lights themselves, either to increase or diminish their brilliancy.

These tables, which are 10 inches wide and 35 inches high, and the one of them 12 feet, and the other 20 feet long, are placed at an angle of 60° from each other, and in such a situation with respect to the photometer, that lines drawn through their middles in the direction of their lengths, meet in a point exactly under the middle of the vertical plane or field of the

photometer, and from that point the distances of the lights are measured; the sides of the tables being divided into English inches, and a Vernier, showing tenths of inches, being fixed to each of the sliding carriages upon which the lights are placed.

These carriages are so contrived that they can be raised or lowered at pleasure, which is absolutely necessary in order that the lights may be always of a proper height, namely, that they may be in a horizontal line with the tops of the cylinders of the photometer.

The method of ascertaining when the lights are at the proper height has already been described.

In order that the two long and narrow tables, or platforms just described, upon which the lights move, may remain immoveable in their proper positions, they are both firmly fixed to the stand which supports the photometer; and in order that the motion of the carriages which carry the lights may be as soft and gentle as possible, they are made to slide upon parallel brass wires, 9 inches asunder, about $\frac{1}{10}$ of an inch in diameter, and well polished, which are stretched out upon the tables from one end to the other.

The pane of glass covered with white paper, which being fixed in a groove in the back of the box, constitutes the vertical plane upon which the shadows are projected, is $5\frac{1}{2}$ inches long, and $3\frac{1}{4}$ inches wide, as has already been observed; which is much larger than the dimensions assigned above for the field; namely, $1\frac{7}{10}$ inches wide, and 2 inches high. I had two objects in view in this arrangement; first, to render it easier to fix this plane in its proper position; and secondly, to be able to augment occasionally the dimensions of the field,

by removing entirely the black pasteboard screen from before this plane, or making use of another with a larger aperture; which is sometimes advantageous.*

Having now, as I imagine, sufficiently described all the essential parts of these instruments, it remains for me to give some account of the precautions which, from experience, I have found it necessary to take in making use of them.

And first, with respect to the distance at which lights whose intensities are to be compared should be placed from the field of the photometer, I have found that when the weakest of the lights in question is about as strong as a common wax-candle, that light may most advantageously be placed from 30 to 36 inches from the centre of the field; and when it is weaker or stronger, proportionally nearer or farther off. When the lights are too near, the shadows will not be well defined; and when they are too far off, they will be too weak.

It will greatly facilitate the calculations necessary in drawing conclusions from experiments of this kind, if some steady light of a proper degree of strength for that purpose be assumed as a standard, by which all others may be compared. I have chosen for that purpose an ARGAND's lamp, made in London, and very well finished; and though the quantity of light emitted by this, or any other kind of lamp, is very various,

* Since writing the above, I have made a little alteration in the form of the box which contains my photometer. The front of it, instead of being open, is now closed, and the light is admitted through two horizontal tubes, which are placed so as to form an angle of 60°; their axes meeting at the centre of the field of the instrument. The field of the photometer is viewed through an opening made for that purpose in the middle of the front of the box, between the two tubes abovementioned. The annexed figures, Tab. X. XI. XII. XIII. will serve to give a clearer idea of the instrument, as it now is, in its most improved state.

depending in a great measure upon the length to which the wick is drawn out, yet I have found by repeated trials that this lamp, once properly adjusted, continues to emit light more equally for a considerable time than any other lamp, and much more so than any candle whatever.

At the beginning of each experiment I adjust this standard light in the following manner. Having placed the lamp upon its carriage, at the distance of 100 inches from the centre of the field of the photometer, measuring from the centre of the circular flame of the lamp, a cylindric wax-candle, of known weight and dimensions, and which is kept merely for that purpose, being lighted and trimmed, and made to burn with the greatest possible degree of brilliancy, is placed over against it, at a certain given distance (33 inches), and then the wick of the lamp is drawn out, or shortened, as it is found necessary, till the shadows corresponding to the lamp and to the candle, are precisely of the same density; this done, the proof candle is extinguished, and laid by for further use, and the projected experiment is immediately commenced.

Here the proof candle is, properly speaking, the standard, but the lamp is to be preferred to it for the experiments, on account of the superior constancy or equality of its light.

The only danger of error in this matter arises from the difficulty of procuring proof candles, which shall always give precisely the same quantity of light, or of making the same candle burn with exactly the same brilliancy at different times; I flattered myself at one time that even this cause of error and uncertainty, however insurmountable the difficulty appears, might be in a great measure removed. I conceived that if the light from the standard lamp and that of the proof candle,

brought to be of the same intensity at the surface of the vertical plane, were really stronger at one time than at another, the equal shadows of the cylinders would be proportionally deeper, and that by comparing, at different times, the density of those shadows with a painted scale of shades, regularly graduated, any difference in the intensity of the standard light might be discovered and compensated; but upon making the experiment I found, what indeed a little patient reflection would have enabled me to foresee, that the apparent density of the two equal shadows corresponding to the lights compared with a painted scale of shades, *exposed in the same light*, is ever the same, however the intensity of the rays at the surface upon which those shadows are projected may vary.

There is however another method by which I think it probable that the standard lamp may be adjusted with the requisite degree of precision. It appears, from a considerable number of experiments, of which I shall hereafter give a more particular account, that the quantity of light emitted by a lamp which burns in the same manner, with a clear flame, *and without smoke*, is in all cases as the quantity of oil consumed. If, therefore, the standard lamp be so adjusted as always to consume a certain given quantity of oil in a given time, there is much reason to suppose that it may then be depended on as a just standard of light.

In order to abridge the calculations necessary in these inquiries, it will always be advantageous to place the standard lamp at the distance of 100 inches of the photometer, and to assume the intensity of its light at its source equal to unity; in this case (calling this standard light A, the intensity of the light at its source $= x = 1$; and the distance of the lamp from

the field of the photometer $= m = 100$;) the intensity of the illumination at the field of the photometer ($= \frac{x}{m^2}$*) will be expressed by the fraction $\frac{1}{100^2} = \frac{1}{10000}$; and the relative intensity of any other light which is compared with it, according to the directions before given, may be found by the following proportion: calling this light B, putting $y =$ its intensity at its source, and $n =$ its distance from the field of the photometer, expressed in English inches, as it is $\frac{y}{n^2} = \frac{x}{m^2}$ as was shewn in my former letter, or instead of $\frac{x}{m^2}$, writing its value $= \frac{1}{10000}$ it will be $\frac{y}{n^2} = \frac{1}{10000}$, and consequently y is to 1 as n^2 is to 10000; or the intensity of the light B at its source, is to the intensity of the standard light A at its source, as the square of the distance of the light B from the middle of the field of the instrument, expressed in inches, is to 10000; and hence it is $y = \frac{n^2}{10000}$.

Or, if the light of the sun or that of the moon be compared with the light of a given lamp or candle C, the result of such comparison may best be expressed in words, by saying, that the light of the celestial luminary in question, *at the surface of the earth*, or which is the same thing, at the field of the photometer, is equal to the light of the given lamp or candle, *at the distance found by the experiment*; or putting $a =$ the intensity of the light of this lamp C at its source, and $p =$ its distance in inches from the field, when the shadows corresponding to this light, and that corresponding to the celestial luminary in question, are found to be of equal densities; and putting $z =$ the intensity of the rays of the luminary at the surface of the earth, the result of the experiment may be expressed thus, $z = \frac{a}{p^2}$;

* See my former letter.

or the real value of *a* being determined by a particular experiment, made expressly for that purpose with the standard lamp, that value may be written instead of it. When the standard lamp itself is made use of, instead of the lamp C, then the value of *a* will be 1.

I have been the more particular in this account of the instruments employed in these inquiries, the manner in which the experiments were conducted, and the principles upon which the conclusions drawn from them are founded, not only because the subject being new, the most particular information upon all these points is absolutely necessary, to enable others to judge with certainty of the matter submitted to their examination, but also because I was very desirous of affording every information and assistance in my power to those who may be disposed to prosecute these very curious and entertaining researches.

Hoping that this apology may be thought sufficient to excuse the prolixity of these descriptions, I shall now proceed to give a short account of such experiments as I have hitherto found leisure to make with this apparatus.

My first attempts were to determine how far it might be possible to ascertain, by direct experiments, the certainty of the assumed law of the diminution of the intensity of the light emitted by luminous bodies; namely, that the intensity of the light is every where as the squares of the distances from the luminous body inversely. These experiments appeared to me the more necessary, as it is quite evident that this law can only hold good when the light is propagated in perfectly transparent or unresisting spaces, or where, suffering no diminution whatever from the medium, its intensity is weakened.

merely in consequence of the divergency of the rays; and as it is more than probable that air, even in its purest state, is far from being perfectly transparent.

For greater perspicuity I shall arrange all my experiments and inquiries under general heads, and shall begin by prefixing to those which relate to the subject now under consideration, the general title of

Experiments upon the Resistance of the Air to Light.

EXPERIMENT I.

Two equal wax-candles, well trimmed, and which were found by a previous experiment to burn with exactly the same degree of brightness, were placed *together*, on one side, before the photometer, and their united light was counterbalanced by the light of an ARGAND's lamp, well trimmed, and burning very equally, placed on the other side over against them. The lamp was placed at the distance of 100 inches from the field of the photometer, and it was found that the two burning candles (which were placed as near together as possible, without their flames affecting each other by the currents of air they produced), were just able to counterbalance the light of the lamp at the field of the photometer, when they were placed at the distance of 60,8 inches from that field. One of the candles being now taken away and extinguished, the other was brought nearer to the field of the instrument, till its light was found to be just able, singly, to counterbalance the light of the lamp; and this was found to happen when it had arrived at the distance of 43,4 inches.

In this experiment, as the candles burnt with equal brightness, it is evident that the intensities of their united and single lights were as 2 to 1, and in that proportion ought, according to the assumed theory, the squares of the distances, 60,8 and 43,4 to be; and in fact, $\overline{60,8}^2 = 3696,64$ is to $\overline{43,4}^2 = 1883,56$ as 2 is to 1 very nearly.

Again, in another experiment, (No. 2.) the distances were,

with two candles = 54 inches. Square = 2916.
with one candle = 38,6. - = 1489,96

Upon another trial (experiment No. 3.)

with two candles = 54,6 inches. Square = 2981,16
with one candle = 39,7. - = 1576,09

And in the 4th experiment

with two candles = 58,4 inches. Square = 3410,56
with one candle = 42,2. - = 1780,84

And taking the mean of the results of these four experiments.

	Squares of the distances.		
	With two candles.		With one candle.
In the experiment No. 1,	3696,64	-	1883,56
No. 2,	2916	-	1489,96
No. 3,	2981,16	-	1576,09
No. 4,	3410,56	-	1780,84
	4) 13004,36	-	4) 6736,45
Means	3251,09	and	1682,61,

which again are very nearly as 2 to 1.

With regard to these experiments it may be observed, that were the resistance of the air to light, or the diminution of the light from the imperfect transparency of air, sensible within

the limits of the inconsiderable distances at which the candles were placed from the photometer, in that case the distance of the two equal lights united ought to be to the distance of one of them single, in a ratio less than that of the square root of 2 to the square root of 1. For if the intensity of a light emitted by a luminous body, *in a space void of all resistance*, be diminished in the proportion of the squares of the distances, it must of necessity be diminished in a still higher ratio when the light passes through a resisting medium, or one which is not perfectly transparent: and from the difference of those ratios, namely, that of the squares of the distances, and that other higher ratio found by the experiment, the resistance of the medium might be ascertained. This I have taken much pains to do with respect to air, but have not as yet succeeded in these endeavours, the transparency of air being so great that the diminution which light suffers in passing through a few inches, or even through several feet of it, is not sensible.

Having found, upon repeated trials, that the light of a lamp, properly trimmed, is incomparably more equal than that of a candle, whose wick continually growing longer renders its light extremely fluctuating, I substituted lamps to candles in these experiments, and made such other variations in the manner of conducting them, as I thought bid fair to lead to a discovery of the resistance of the air to light, were it possible to render that resistance sensible within the confined limits of my machinery.

Having provided two lamps, the one an ARGAND's lamp, which I made to burn with the greatest possible brilliancy; the other a small common lamp, with a single, round, and very small wick, which burning with a very clear, steady flame,

and without any visible smoke, emitted only about $\frac{1}{25}$ part as much light as the ARGAND's lamp; these lamps being placed over against each other before the field of the photometer, their lights were found to be in equilibrium when the less being placed at the distance of 20 inches from the centre of that field, the greater was removed to the distance of 101 inches. I now concluded, that if the less light were to be removed to the distance of 40 inches, it would be necessary, in order to restore the equilibrium of light, or equality of the shadows in the field of the photometer, to remove the greater light to the distance of 202 inches; that is to say, if the diminution of the light arising from the imperfect transparency of the air should not be perceptible within the limits of that distance. But if, on the contrary, it should be found upon repeated trials, that the equilibrium was restored when the greater light had arrived at a distance *short* of 202 inches, I might thence conclude, that such effect might safely be attributed to the imperfect transparency of the air: for notwithstanding that the light of the smaller lamp would of course be diminished as well as that of the greater, yet as there is every reason to suppose that the diminution, whatever it may be, must ever be proportional to the distance through which the light passes in the medium, as the augmentation of the distance through which the light of the smaller lamp passes is no more than 20 inches, while that of the greater is made to pass through an additional distance, amounting to more than 100 inches, it is evident that the diminution of the light of the greater lamp, arising from the imperfect transparency of the medium, must be greater than the diminution of the light of the less lamp, arising from the same cause; and, consequently,

that the effects of such diminution would become apparent in the experiment, were they in reality considerable.

The following table will shew the results of the experiments which were made with a view to determine that fact.

Experiments.	Distance of the smaller Light.	Distance of the greater Light.	Second distance of the greater light, *computed* according to the assumed law of the squares of the distances	Difference between the result of the experiment and the theory.
	inches.	inches.	inches.	inches.
No. 5.	First dist. 20	First dist. 101		
	Second dist. 40	Second dist. 203	202	+ 1
No. 6.	First dist. 20	First dist. 100,2		
	Second dist. 40	Second dist. 198,3	200,4	— 2,1
No. 7.	First dist. 20	First dist. 100,8		
	Second dist. 40	Second dist. 202,1	201,6	+ 0,5
No. 8.	First dist. 20	First dist. 101,5		
	Second dist. 40	Second dist. 204	203	+ 1
No. 9.	First dist. 50	First dist. 100		
	Second dist. 100	Second dist. 198	200	— 2
No. 10.	First dist. 50	First dist. 95,5		
	Second dist. 100	Second dist. 192,2	191	+ 1,2
No. 11.	First dist. 50	First dist. 95,1		
	Second dist. 100	Second dist. 191,2	190,2	+ 1
No. 12.	First dist. 50	First dist. 96		
	Second dist. 100	Second dist. 192,4	192	+ 0,4

In the four last experiments, instead of the small lamp above described, a common ARGAND lamp was made use of, the wick of which was only drawn out so far as to cause it to emit about $\frac{1}{4}$ part as much light as the other ARGAND's lamp, burning with its greatest brilliancy, which was placed over against it.

In order that in judging of the equality of the shadows, my

mind might be totally unbiassed by my expectations, or by any opinions I might previously have formed with respect to the probable issue of the various experiments, keeping my eye constantly fixed upon the field of the photometer, and causing the light, whose corresponding shadow was to be brought to be of equal density with the standard, to move backwards and forwards, by means of the winch which I had constantly in my hand, as soon as the shadows appeared to me to be perfectly equal, I gave notice to an assistant to observe, and silently to write down, the distance of the lamp or candle, so that I did not even know what that distance was till the experiment was ended, and till it was too late to attempt to correct any supposed errors of my eyes by my wishes, or by my expectations, had I been weak enough to have had a wish in a matter of this kind. I do not know that any predilection I might have had for any favourite theory, would have been able to have operated so strongly upon my mind, and upon my senses, as to have made black and white appear to me otherwise than as they really were; but this I know, that I was very glad to find means to avoid being *led into temptation*.

But to return to the foregoing experiments; the results of them, so far from affording means for ascertaining the resistance of the air to light, do not even indicate any resistance at all; on the contrary, it might almost be inferred from some of them, that the intensity of the light emitted by a luminous body in air is diminished in a ratio *less* than that of the squares of the distances; but as such a conclusion would involve an evident absurdity, namely that, light moving in air, its absolute quantity instead of being diminished actually goes on to *increase*, that conclusion can by no means be admitted.

Besides the experiments above mentioned, I made a great number of others similar to them, and with the same view; but as their results were all nearly the same, I have not thought it worth while to lengthen my letter by inserting a particular account of them. In general they all conspired to shew that the resistance of the air to light was too inconsiderable to be perceptible; and that the assumed law of the diminution of the intensity of the light may with safety be depended on.

That the transparency of air in its purest state is very great, is evident from the very considerable distances at which objects, and such even as are but faintly illuminated, are visible; and I was by no means surprised that its want of transparency could not be rendered sensible in the small distance to which my experiments were necessarily confined: but still I think means may be found for rendering its resistance to light apparent, and even of subjecting that resistance to some tolerably accurate measure.

An accurate determination of the relative intensity of the sun's or moon's light, when seen at different heights above the horizon, or when seen from the top, and from the bottom of a very high mountain, in very clear weather, would probably lead to a discovery of the real amount of the resistance of the air to light.

Of the Loss of Light in its Passage through Plates or Panes of different Kinds of Glass.

In these experiments I proceeded in the following manner. Having provided two equal ARGAND's lamps, A and B, well trimmed, and burning with very clear bright flames, they

were placed over against each other before the photometer, each at the distance of 100 inches from the field of the instrument, and the light of B was brought to be of the same intensity as that of A, or the shadows were brought to be of the same density, which was done by lengthening or shortening the wick of the lamp B, as the occasion required. This done, and the two lamps now burning with precisely the same degree of brilliancy, a pane of fine, clear, transparent, well polished glass, such as is commonly made use of in the construction of looking-glasses, six inches square, placed vertically upon a stand, in a small frame, was interposed before the lamp B, at the distance of about four feet from it, and in such a position that the light emitted by it was obliged to go perpendicularly through the middle of the pane, in order to arrive at the field of the photometer. The consequence of this was, that the light of the lamp B being diminished and weakened in its passage through the glass, the illuminations of the shadows in the field of the photometer were no longer equal, the shadow corresponding to the lamp A being now less enlightened by the light of the lamp B, than the shadow corresponding to the lamp B was enlightened by the undiminished light of the lamp A.

To determine precisely the exact amount of this diminution of the light of the lamp B (which was the main object of the experiment), nothing more was necessary than to bring this lamp nearer to the field of the photometer, till its light passing through the glass should be in equilibrium with the direct light of the lamp A; or, in other words, till the equality of the shadows should be restored; and this I found

actually happened when the lamp B, from 100 inches, was brought to the distance of 90,2 inches from the field of the photometer.

Now as it has already been shewn that the intensities of the lights are as the squares of their distances from the field of the photometer, the illuminations being equal at that field, it is evident that the light of the lamp B was diminished, in this experiment, in its passage through the pane of glass, in the ratio of $\overline{100}^2$ to $\overline{90,2}^2$, or as 1 to ,8136; so that no more than ,8136 parts of the light which impinged against the glass found its way through it; the other ,1864 parts being dispersed and lost.

To assure myself that the lamps still continued to emit the same relative quantities of light as at the beginning of the experiment, I now removed the pane of glass, and found that the equality of the shadows was again restored, when the lamp B arrived at its former station, 100 inches from the field of the photometer.

This experiment I repeated no less than 10 times, and found the loss of light in its passage through this pane of glass, taking a mean of all the experiments, to be ,1973 parts of the whole quantity that impinged against it; the variations in the results of the various experiments being from ,1720 to ,2108.

In four experiments, with another pane of the same kind of glass, the loss of light was ,1836; ,1732; ,2056; and ,1853; mean ,1869.

When the two panes of this glass were placed before the lamp B, at the same time, but without touching each other,

and the light made to pass through them both, the loss of light, in four different experiments, was ,3089; ,3259; ,3209; and ,3180; mean ,3184.

With another pane of glass of the same kind, but a little thinner, the mean loss of light, in four experiments, was ,1813.

With a very thin clean, pane of clear, white, or colourless window-glass, not ground, the loss of light, in four experiments, was ,1324; ,1218; ,1213; and ,1297; mean ,1263. When the experiment was made with this same pane of glass, a very little dirty, the loss of light was more than doubled.

Might not this apparatus be very usefully employed by the optician, to determine the degree of transparency of the glass he employs, and direct his choice in the provision of that important article in his trade?

In making these experiments, a great deal of the trouble may well be spared, for there is no use whatever in bringing the two lamps A and B to burn with the same degree of brilliancy; all that is necessary being to bring the shadows to be of the same density, with the glass, and without it, noting the distance of the lamp B in each case (the lamp A remaining immoveable in its place); for the relative quantity of light lost will ever be accurately shewn by the ratio of the squares of those distances, whatever be the relative brilliancy with which the two lamps burn. The experiment is more striking, and the consequences drawn from it rather more obvious, when the lamps are made to burn with equal flames; otherwise that equality is of no real advantage.

Of the Loss of Light in its Reflection from the Surface of a plane Glass Mirror.

In these experiments the method of proceeding was much the same as in those just mentioned. The lamps A and B burning with clear, bright, and steady flames, were placed before the field of the photometer, and one of them was moved backwards and forwards till the illuminations of the shadows in the field of the instrument were found to be precisely equal. The distance of the lamp B being then noted, this lamp was removed, and a mirror being put in its place, but nearer the field of the photometer, the lamp was so placed that its rays, striking the centre of the mirror, were reflected against the field of the photometer, where, by bringing the lamp nearer to, or removing it farther from the mirror, the illumination of the field by those reflected rays was now brought to be in equilibrium with the illumination of the standard lamp, and then the distance of the lamp from the centre of the mirror, and the distance from thence to the centre of the field, were carefully measured, and noted. These two distances added together, was the real distance through which the rays passed in order to arrive at the field of the photometer.

Now as there is always a loss of light in reflection, it is evident that the reflected rays must come to the field of the photometer weakened, and that in order to illuminate this field by these reflected rays as strongly as it was illuminated by the direct rays of the same lamp, the lamp must be brought nearer to the field. It is likewise evident, from what has already been said, that the ratio of the squares of those distances of the lamp when its rays pass on directly, and when they

arrive after having been reflected, are found to illuminate equally the field of the photometer, will be an accurate measure of the loss of the light in reflection.

The following table will shew the results of five experiments with a small, but most excellent glass mirror, made by RAMSDEN. This mirror, which makes part of an optical instrument I caused to be constructed in London about twelve years ago, is 7 inches long, and $5\frac{1}{2}$ inches wide, and I suppose is as perfect as ever glass mirror was of that size.

To facilitate the comparison of the results of the experiments, the lamp B, at the beginning of each experiment (when the intensity of its direct rays was compared with the intensity of the standard lamp), was placed at the distance of 100 inches, the standard lamp being occasionally moved, in order to produce an equality of the shadows.

Experiments.	The angle of incidence.	Distance of the centre of the mirror from the centre of the field.	Distance of the lamp from the centre of the mirror.	Real distance of the lamp, or length of the reflected rays.	Light lost in the reflection.
		inches.	inches.	inches.	parts.
1	60°	40	40,8	80,8	,3472
2	85°	—	41,	81,	,3439
3	45°	—	41,5	81,5	,3358
4	60°	—	39,5	79,5	,3680
5	70°	—	40,5	80,5	,3520

The mean of these five experiments gives for the loss of light ,3494; and from hence it appears, that more than $\frac{1}{3}$ part of the light which falls upon the best glass mirror that can be constructed is lost in reflection.

The loss with mirrors of indifferent quality, is still more considerable. With a very bad common looking-glass the loss,

in one experiment, appeared to be ,4816 parts; and with another looking-glass it was ,4548 parts in one experiment, and ,4430 in another. I should certainly have made an experiment to determine the loss of light in its reflection from the surface of a plane metallic mirror, but I had no such mirror at hand.

The difference of the angles of incidence at the surface of the mirror, within the limits mentioned, namely, from 45° to 85°, did not appear to affect, in any sensible degree, the results of the experiments. I also found upon trial, that the effect produced by the difference of the angles at which light impinges against a sheet of transparent glass through which it passes, is, within the limits of 40° or 50° from the perpendicular, but very trifling.

Of the relative Quantities of Oil consumed, and of Light emitted, by an ARGAND's *Lamp, and by a Lamp on the common Construction, with a Riband Wick.*

The brilliancy of the ARGAND's lamp is not only unrivalled, but the invention is in the highest degree ingenious, and the instrument useful for many purposes; but still, to judge of its real merits as an illuminator, it was necessary to know whether it gives more light than another lamp *in proportion to the oil consumed.* This point I determined in the following manner.

Having placed an ARGAND's lamp, well trimmed, and burning with its greatest brilliancy, before my photometer, and over against it a very excellent common lamp, with a riband wick, about an inch wide, and which burnt with a

clear, bright flame, without the least appearance of smoke, I found the intensities of the light emitted by the two lamps to be to each other as 17956 to 9063; the densities of the shadows being equal when the ARGAND's being placed at the distance of 134 inches, the common lamp was placed at the distance of 95,2 inches, from the field of the photometer.

Both lamps having been very exactly weighed when they were lighted, they were now (without being removed from their places before the photometer), caused to burn with the same brilliancy just 30 minutes; when they were extinguished and weighed again, and were found to have consumed of oil, the ARGAND's lamp $\frac{253}{8192}$, and the common lamp $\frac{163}{8192}$ of a Bavarian pound.

Now as the quantity of light produced by the ARGAND's lamp, in this experiment, is to the quantity produced by the common lamp, as 17956 to 9063, or as 187 to 100; while the quantity of oil consumed by the former is to that consumed by the latter only in the ratio of 253 to 163, or as 155 to 100, it is evident that the quantity of light produced by the combustion of a given quantity of oil in an ARGAND's lamp is greater than that produced by burning the same quantity in a common lamp, in the ratio of 187 to 155, or as 100 to 85.

The saving, therefore, of oil which arises from making use of an ARGAND's lamp instead of a common lamp in the production of light, is evident; and it appears from this experiment that that saving cannot amount to less than 15 *per cent.* How far the advantage of this saving may, under certain circumstances, be counterbalanced by inconveniences that may attend the making use of this improved lamp, I will not pretend to determine.

Of the relative Quantities of Light emitted by an ARGAND'S *Lamp, and by a common Wax Candle.*

I have made a considerable number of experiments to determine this point, and the general result of them is, that a common ARGAND'S lamp, burning with its usual brightness, gives about as much light as nine good wax candles; but the sizes and qualities of candles are so various, and the light produced by the same candle so fluctuating, that it is very difficult to ascertain, with any kind of precision, what a common wax candle is, or how much light it ought to give. I once found that my ARGAND'S lamp, when it was burning with its greatest brilliancy, gave twelve times as much light as a good wax candle $\frac{3}{4}$ of an inch in diameter, but never more.

Of the Fluctuations of the Light emitted by Candles.

To determine to what the ordinary variations in the quantity of light emitted by a common wax candle might amount, I took such a candle, and lighting it, placed it before the photometer, and over against it an ARGAND'S lamp, which was burning with a very steady flame; and measuring the intensity of the light emitted by the candle from time to time, during an hour, the candle being occasionally snuffed when it appeared to stand in need of it, its light was found to vary from 100 to about 60. The light of a wax candle of an inferior quality was still more unequal, but even this was but trifling compared to the inequalities of the light of a tallow candle.

An ordinary tallow candle, of rather an inferior quality, having been just snuffed, and burning with its greatest bril-

liancy, its light was as 100; in eleven minutes it was but 39; after eight minutes more had elapsed, its light was reduced to 23; and in ten minutes more, or twenty-nine minutes after it had been last snuffed, its light was reduced to 16. Upon being again snuffed it recovered its original brilliancy, 100.

Of the relative Quantities of Bees Wax, Tallow, Olive Oil, Rape Oil, and Linseed Oil, consumed in the Production of Light.

In order to ascertain the relative quantities of bees wax and of olive oil consumed in the production of light, I proceeded in the following manner. Having provided an end of a wax candle of the best quality, ,68 of an inch in diameter, and about four inches in length, and a lamp with five small wicks, which I had found upon trial to give the same quantity of light as the candle, I weighed very exactly the candle, and the lamp filled with oil, and then placing them at equal distances (40 inches) before the field of the photometer, I lighted them both at the same time; and after having caused them to burn with precisely the same degree of brightness *just one complete hour*, I extinguished them both, and weighing them a second time, I found that 100 parts of wax, and 129 parts of oil, had been consumed.

Hence it appears, that the consumption of bees wax is to the consumption of olive oil, in the production of the same given quantity of light, as 100 is to 129.

In this experiment no circumstance was neglected that could tend to render the result of it conclusive. Care was taken to snuff the candle very often with a pair of sharp scissars, in order to make it burn constantly with the same degree of brilliancy;

and the light of the lamp was, during the whole time, kept in the most exact equilibrium with the light of the candle; which was easily done by occasionally drawing out, a little more or less, one or more of its five equal wicks. These wicks, which were placed in a right line perpendicular to a line drawn from the middle wick to the middle of the field of the photometer, were about $\frac{1}{10}$ of an inch in diameter each, and $\frac{1}{4}$ of an inch from each other, and when they were lighted, their flames united into one broad, thin, and very clear, white flame, without the least appearance of smoke.

In order to ascertain the relative consumption of olive oil and rape oil, in the production of light, two lamps, like that just described, were made use of; and the experiment being made with all possible care, the consumption of olive oil appeared to be to that of rape oil, in the production of the same quantity of light, as 129 is to 125.

The experiment being afterwards repeated with olive oil and very pure linseed oil, the consumption of olive oil appeared to be to that of the linseed oil as 129 to 120.

The experiment being twice made with olive oil, and with a tallow candle; once when the candle, by being often snuffed, was made to burn constantly with the greatest possible brilliancy, and once when it was suffered to burn the whole time with a very dim light, owing to the want of snuffing, the results of these experiments were very remarkable.

When the candle burnt with a clear, bright flame, the consumption of the olive oil was to the consumption of the tallow as 129 is to 101; but when the candle burnt with a dim light, the consumption of the olive oil was to the consumption of the tallow as 129 is to 229. So that it appeared from this last

experiment, that the tallow, instead of being nearly as productive of light in its combustion as bees wax, as it appeared to be when the candle was kept constantly well snuffed, was now, when the candle was suffered to burn with a dim light, by far less so than oil.

But this is not all; what is still more extraordinary is, that the very same candle, burning with a long wick, and a dim light, actually consumed *more tallow* than when, being properly snuffed, it burnt with a clear, bright flame, and gave near *three times as much light!*

To be enabled to judge of the relative quantities of light actually produced by the candle in the two experiments, it will suffice to know, that in order to counterbalance this light at the field of the photometer, it required, in the former experiment, the consumption of 141 parts, but in the latter only the consumption of 64 parts of olive oil. But in the former experiment 110 parts, and in the latter 114 parts of tallow were actually found to be consumed. These parts were 8192ths of a Bavarian pound.

From the results of all the foregoing experiments it appears, that the relative expence of the undermentioned inflammable substances, in the production of light, is as follows.

		Equal parts in weight.
Bees wax.	A good wax candle, kept well snuffed, and burning with a clear, bright flame, - - -	100
Tallow.	A good tallow candle, kept well snuffed, and burning with a bright flame,	101
	The same tallow candle, burning very dim for want of snuffing, -	229

		Equal parts in weight.
Olive oil.	Burnt in an ARGAND's lamp, -	110
	The same burnt in a common lamp, with a clear, bright flame, without smoke, - - -	129
Rape oil.	Burnt in the same manner, -	125
Linseed oil.	Likewise burnt in the same manner,	120

I should have been very glad to have made the experiment with whale oil, but there was none to be had in the country I inhabit.

With the foregoing table, and the prices current of the therein mentioned articles, the relative prices of light produced by those different materials may very readily be computed.

The light of a wax candle, for instance, costs just *nine times* more at Munich, than the same quantity of light produced by burning rape oil in an ARGAND's lamp.

Of the Transparency of Flame.

To ascertain the transparency of flame, or the measure of the resistance it opposes to the passage of foreign or extraneous light through it, I placed before the photometer, over against the standard lamp, two burning wax candles, well trimmed; and putting them near together, sometimes by the sides of each other, and sometimes in a straight line behind each other, I found that when their distances from the field of the photometer were the same, the intensity of the illumination was to all appearance the same, whether the light of the one was made to pass through the flame of the other, or not. And

the same held good, with very little variation, when three, and even when four candles were made use of in the experiment, instead of two.

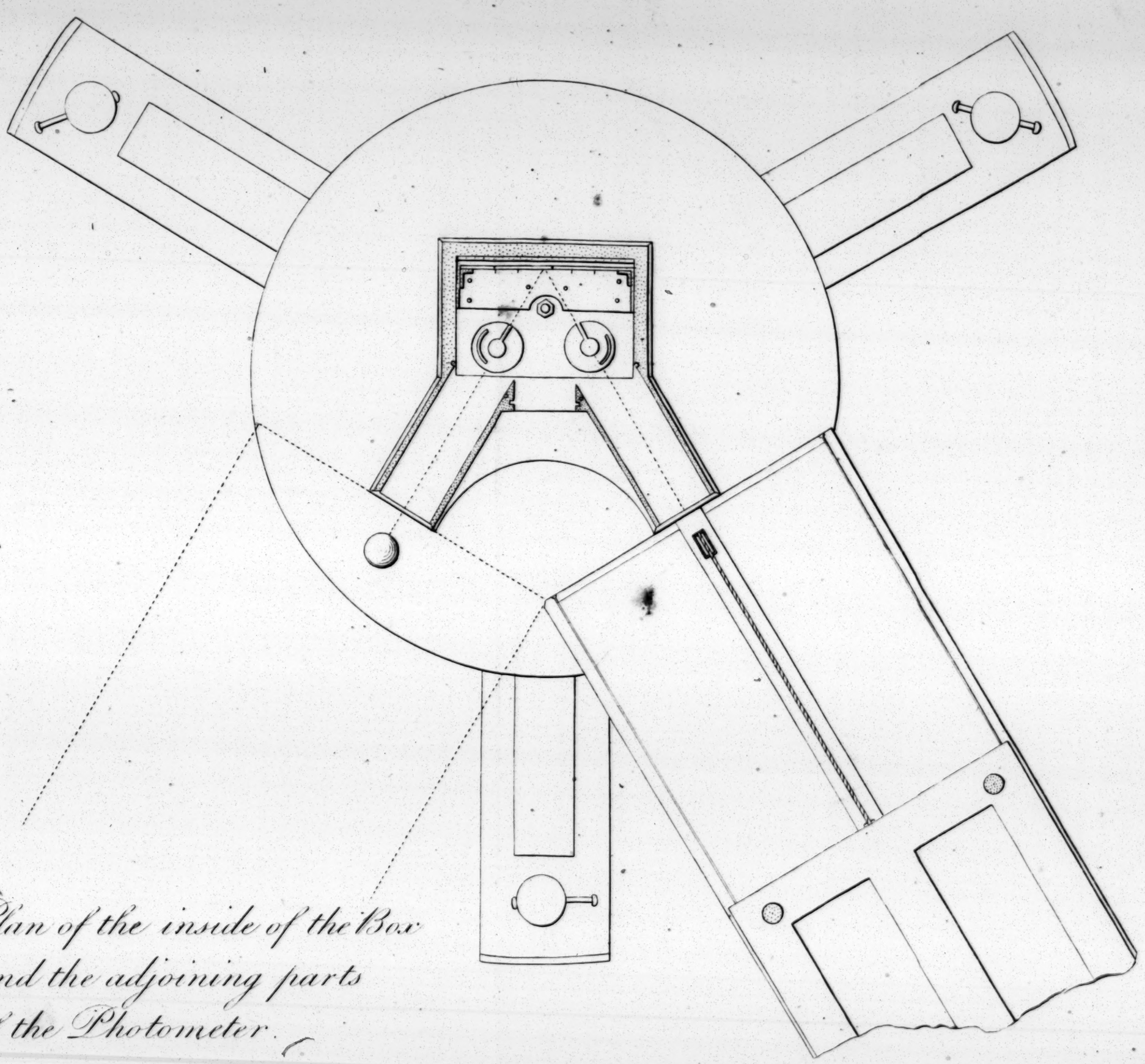
I even caused a lamp to be constructed with nine round wicks, placed in an horizontal line, and just so far asunder as to prevent their flames uniting, and no farther. And I found, upon repeating the experiment with this lamp, that the result was much the same as with the candles; the intensity of the illumination at the field of the photometer being very nearly the same, whether these nine lights were placed so as to cover, and pass through each other, or not.

But I afterwards found means to demonstrate the very great transparency of flame by a still more simple experiment. Suspecting that the only reason why bodies are not visible through a sheet of vivid flame is, that the light of the flame affects the eye in such a manner as to render it insensible to the weaker light emitted by, or reflected from the objects placed behind it, I conceived that a very strong light would not only be visible through a weak flame, but also (as all transparent bodies are invisible) that it might perhaps cause the flame totally to disappear; to determine that fact, I took a lighted candle at mid-day, the sun shining moderately bright, and holding it up between my eye and the sun, I found the flame of the candle to disappear entirely. It was not even necessary, in order to cause the flame to become invisible, to bring it to be directly between the eye and the body of the sun; it was sufficient for that purpose to bring it into the neighbourhood of the sun, where the light was very strong: even in a situation in which the light was not so strong as to dazzle the eye so much

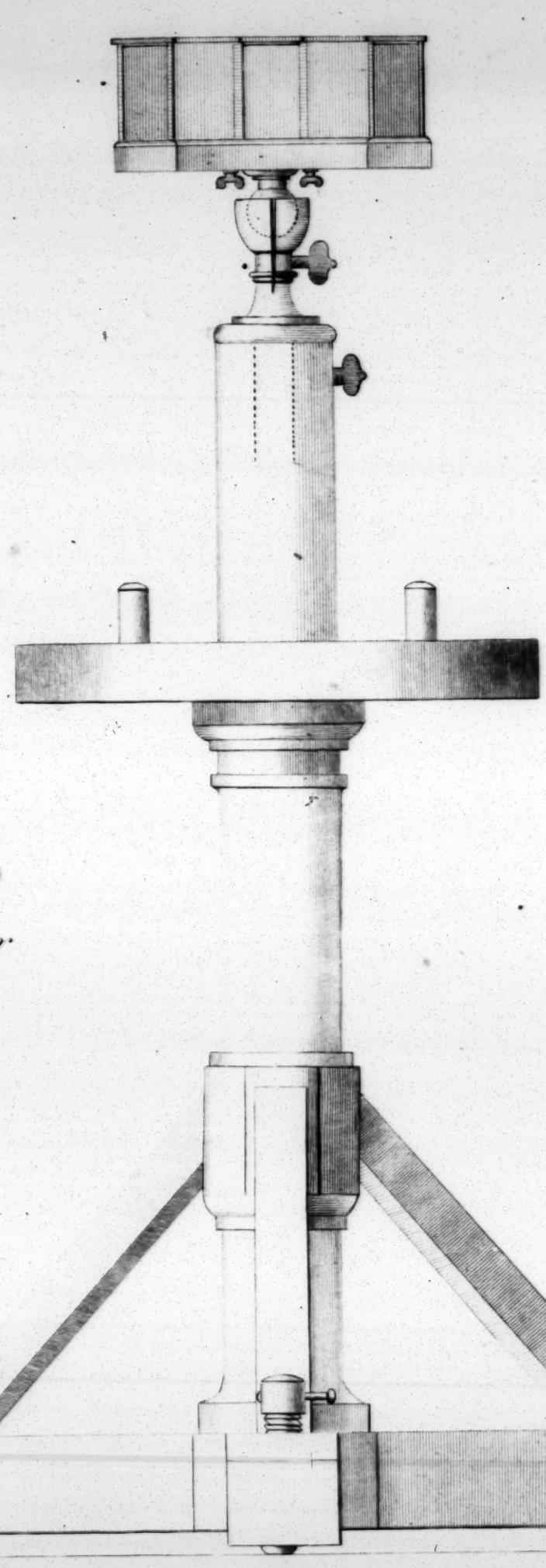
as to prevent its seeing very distinctly the body of the candle, and the wick, not the least appearance of flame was discernible, though the candle actually burnt the whole time very vigorously.

Munich,
1st March, 1793.

I am, &c.



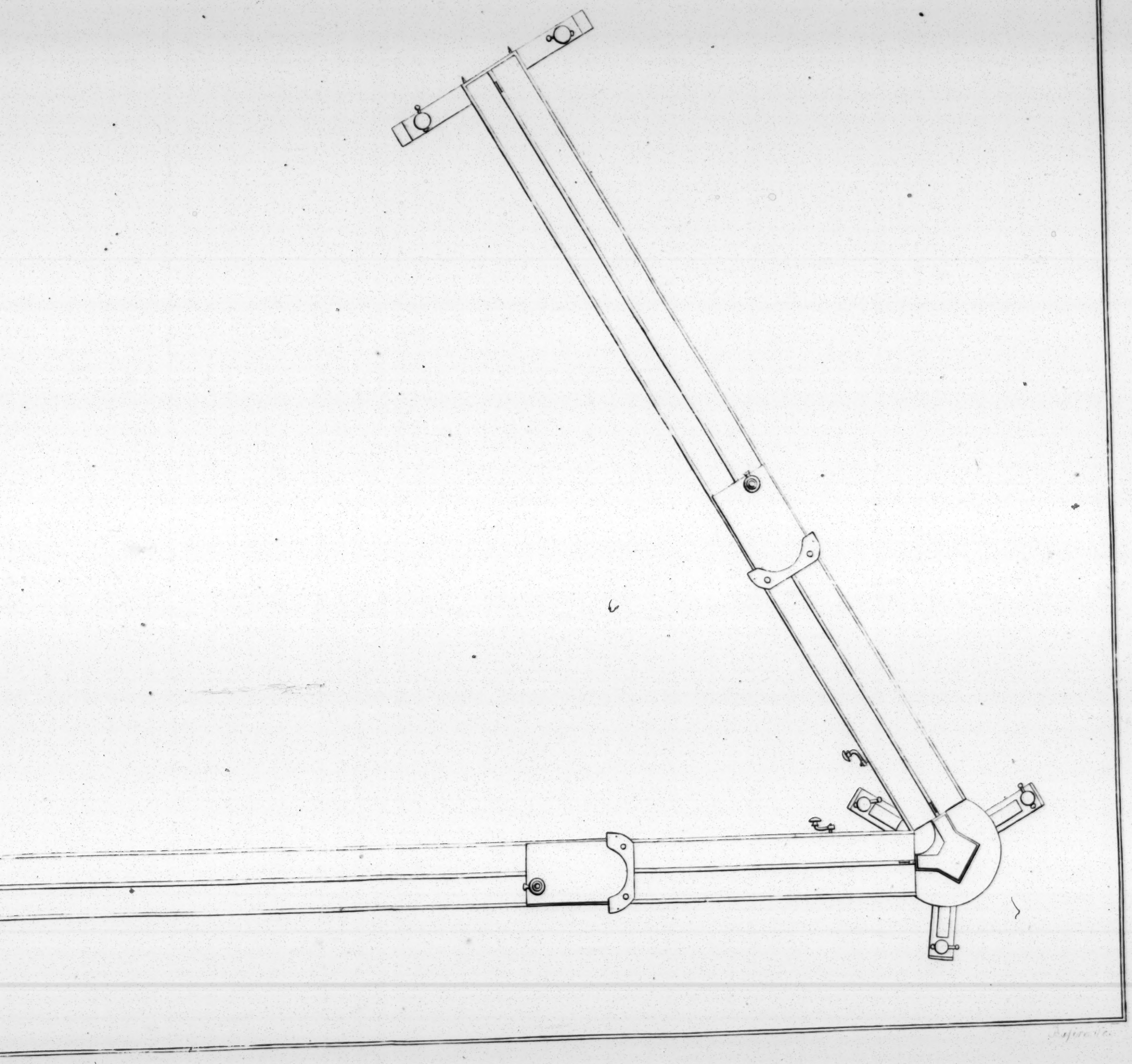
Plan of the inside of the Box and the adjoining parts of the Photometer.

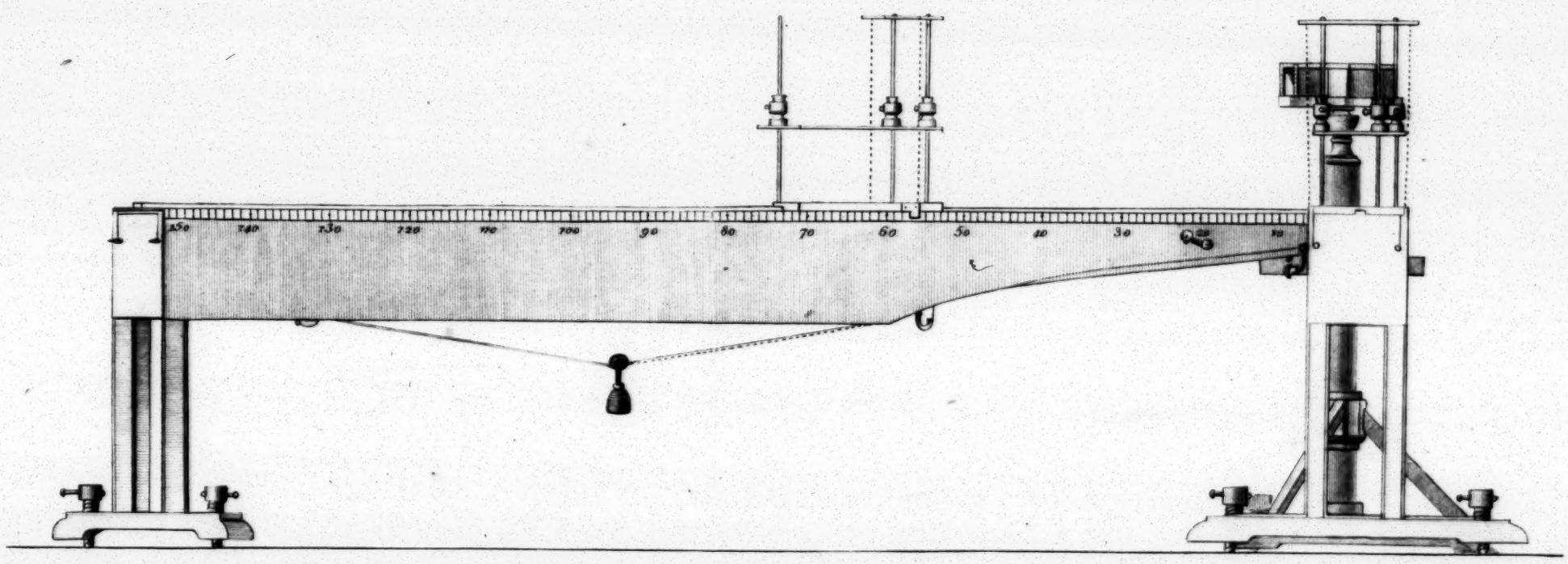


The Box of the Photometer on its stand.

Barlow del.

Plan of the two Tables
belonging to the Photometer.





Elevation of the Photometer, with one of the Tables & Carriages.

Basire Sc.

X. *An Account of some Experiments upon coloured Shadows.* By *Lieutenant-General Sir* Benjamin Thompson, *Count of* Rumford, *F. R. S. In a Letter to Sir* Joseph Banks, *Bart. P. R. S.*

Read February 20, 1794.

DEAR SIR,

SINCE my last letter, being employed in the prosecution of my experiments upon light, I was struck with a very beautiful, and what to me appeared to be a new appearance. Desirous of comparing the intensity of the light of a clear sky, by day, with that of a common wax candle, I darkened my room, and letting the daylight from the north, coming through a hole near the top of the window-shutter, fall at an angle of about 70° upon a sheet of very fine white paper, I placed a burning wax candle in such a position that its rays fell upon the same paper, and as near as I could guess, in the line of reflection of the rays of daylight from without; when interposing a cylinder of wood, about half an inch in diameter, before the centre of the paper, and at the distance of about two inches from its surface, I was much surprised to find that the two shadows projected by the cylinder upon the paper, instead of being merely shades without colour, as I expected, the one of them, that which, corresponding with the beam of daylight, was illuminated by the candle, was *yellow*; while the other,

corresponding to the light of the candle, and consequently illuminated by the light of the heavens, was of the most beautiful *blue* that it is possible to imagine. This appearance, which was not only unexpected, but was really in itself in the highest degree striking and beautiful, I found, upon repeated trials, and after varying the experiment in every way I could think of, to be so perfectly permanent, that it is absolutely impossible to produce two shadows at the same time from the same body, the one answering to a beam of daylight, and the other to the light of a candle or lamp, without these shadows being coloured, the one *yellow* and the other *blue*.

The experiment may very easily be made at any time by day, and almost in any place, and even by a person not in the least degree versed in experimental researches. Nothing more is necessary for that purpose than to take a burning candle into a darkened room in the day time, and open one of the window-shutters a little, about half or three quarters of an inch for instance; when the candle being placed upon a table or stand, or given to an assistant to hold, in such a situation that the rays from the candle may meet those of daylight from without, at an angle of about 40°, at the surface of a sheet of white paper, held in a proper position to receive them, any solid opaque body, a cylinder, or even a finger, held before the paper, at the distance of two or three inches, will project two shadows upon the paper, the one blue, and the other yellow.

If the candle be brought nearer to the paper, the blue shadow will become of a deeper hue, and the yellow shadow will gradually grow fainter; but if it be removed farther off, the yellow shadow will become of a deeper colour, and the blue shadow will become fainter; and the candle remaining

stationary in the same place, the same varieties in the strength of the tints of the coloured shadows may be produced merely by opening the window-shutter a little more or less, and rendering the illumination of the paper by the light from without stronger or weaker. By either of these means, the coloured shadows may be made to pass through all the gradations of shade, from the deepest to the lightest, and *vice versa*; and it is not a little amusing to see shadows, thus glowing with all the brilliancy of the purest and most intense prismatic colours, then passing suddenly through all the varieties of shade, preserving in all the most perfect purity of tint, growing stronger and fainter, and vanishing and returning at command.

With respect to the causes of the colours of these shadows, there is no doubt but they arise from the different qualities of the light by which they are illuminated; but how they are produced, does not appear to me so evident. That the shadow corresponding to the beam of daylight, which is illuminated by the yellow light of a candle, should be of a yellowish hue, is not surprising; but why is the shadow corresponding to the light of the candle, and which is illuminated by no other light than the apparently white light of the heavens, *blue?* I at first thought that it might arise from the blueness of the sky; but finding that the broad daylight, reflected from the roof of a neighbouring house covered with the whitest new fallen snow, produced the same blue colour, and if possible of a still more beautiful tint, I was obliged to abandon that opinion.

To ascertain with some degree of precision the real colour of the light emitted by a candle, I placed a lighted wax candle,

well trimmed, in the open air, at mid-day, at a time when the ground was deeply covered with new fallen snow, and the heavens were overspread with white clouds; when the flame of the candle, far from being white, as it appears to be when viewed by night, was evidently of a very decided yellow colour, not even approaching to whiteness. The flame of an ARGAND'S lamp, exposed at the same time in the open air, appeared to be of the same yellow hue. But the most striking manner of shewing the yellow hue of the light emitted by lamps and candles, is by exposing them in the direct rays of a bright meridian sun. In that situation the flame of an ARGAND'S lamp, burning with its greatest brilliancy, appears in the form of a dead yellow semi-transparent smoke. How transcendently pure and inconceivably bright the rays of the sun are, when compared to the light of any of our artificial illuminators, may be gathered from the result of this experiment.

It appearing to me very probable, that the difference in the whiteness of the two kinds of light, which were the subjects of the foregoing experiments, might, some how or other, be the occasion of the different colours of the shadows, I attempted to produce the same effects by employing two artificial lights of different colours; and in this I succeeded completely.

In a room previously darkened, the light from two burning wax candles being made to fall upon the white paper at a proper angle, in order to form two distinct shadows of the cylinder, these shadows were found not to be in the least coloured; but upon interposing a pane of yellow glass, approaching to a faint orange colour, before one of the candles,

one of the shadows immediately became *yellow*, and the other *blue*. When two ARGAND's lamps were made use of instead of the candles, the result was the same; the shadows were constantly and very deeply coloured, the one yellow approaching to orange, and the other blue approaching to green. I imagined that the greenish cast of this blue colour was owing either to the want of whiteness of the one light, or to the orange hue of the other, which it acquired from the glass.

When equal panes of the same yellow glass were interposed before *both* the lights, the white paper took an orange hue, but the shadows were to all appearance without the least tinge of colour; but *two* panes of the yellow glass being afterwards interposed before one of the lights, while only *one* pane remained before the other, the colours of the shadows immediately returned.

The result of these experiments having confirmed my suspicions, that the colours of the shadows arose from the different degrees of whiteness of the two lights, I now endeavoured, by bringing daylight to be of the same yellow tinge with candle light, by the interposition of sheets of coloured glass, to prevent the shadows being coloured when daylight and candle light were together the subjects of the experiment; and in this I succeeded. I was even able to reverse the colours of the shadows, by causing the daylight to be of a deeper yellow than the candle light. In the course of these experiments I observed, that different shades of yellow given to the daylight produced very different and often quite unexpected effects: thus one sheet of the yellow glass interposed before the beam of daylight, changed the yellow shadow to a lively violet colour, and the blue shadow to a light green; two sheets of.

the same glass nearly destroyed the colours of both the shadows; and three sheets changed the shadow which was originally yellow to blue, and that which was blue to a purplish yellow colour.

When the beam of daylight was made to pass through a sheet of blue glass, the colours of the shadows, the yellow as well as the blue, were improved and rendered in the highest degree clear and brilliant; but when the blue glass was placed before the candle, the colours of the shadows were very much impaired.

In order to see what would be the consequence of rendering the candle light of a still deeper yellow, I interposed before it a sheet of yellow or rather orange-coloured glass, when a very unexpected and most beautiful appearance took place; the colour of the yellow shadow was changed to orange, the blue shadow remained unchanged, and the whole surface of the paper appeared to be tinged of a most beautiful violet colour, approaching to a light crimson or pink; almost exactly the same hue as I have often observed the distant snowy mountains and valleys of the Alps to take about sunset. Is it not more than probable that this hue is in both cases produced by nearly the same combinations of coloured light? in the one case, it is the white snow illuminated at the same time by the purest light of the heavens, and by the deep yellow rays from the west; and in the other, it is the white paper illuminated by broad daylight, and by the rays from a burning candle, rendered still more yellow by being transmitted through the yellow glass. The beautiful violet colour which spreads itself over the surface of the paper will appear to the greatest advantage, if the pane of orange-coloured glass be held in such

a manner before the candle, that only a part of the paper, half of it for instance, be affected by it, the other half of it remaining white.

To make these experiments with more convenience, the paper, which may be about 8 or 10 inches square, should be pasted or glued down upon a flat piece of board, furnished with a ball and socket upon the hinder side of it, and mounted upon a stand; and the cylinder should be fastened to a small arm of wood, or of metal, projecting forward from the bottom of the board for that purpose. A small stand, capable of being made higher or lower as the occasion requires, should likewise be provided for supporting the candle; and if the board with the paper fastened upon it be surrounded with a broad black frame, the experiments will be so much the more striking and beautiful. For still greater convenience, I have added two other stands, for holding the coloured glass through which the light is occasionally made to pass, in its way to the white surface upon which the shadows are projected. It will be hardly necessary to add, that in order to the experiments appearing to the greatest advantage, all light, which is not absolutely necessary to the experiment, must be carefully shut out.

Having fitted up a little apparatus according to the above directions, merely for the purpose of prosecuting these inquiries respecting the coloured shadows, I proceeded to make a great variety of experiments, some with pointed views, and others quite at random, and merely in hopes of making some accidental discovery that might lead to a knowledge of the causes of appearances which still seemed to me to be enveloped in much obscurity and uncertainty.

Having found that the shadows corresponding to two like

wax candles were coloured, the one blue, and the other yellow, by interposing a sheet of yellow glass before one of them; I now tried what the effect would be when blue glass was made use of instead of yellow, and I found it to be the same; the shadows were still coloured, the one blue, and the other yellow, with the difference, however, that the colours of the shadows were reversed, that which, with the yellow glass, was before yellow being now blue, and that which was blue being yellow.

I afterwards tried a glass of a bright amethyst colour, and was surprised to find that the shadows still continued to be coloured blue and yellow. The yellow, it is true, had a dirty purple cast; but the blue, though a little inclining to green, was nevertheless a clean, bright, decided colour.

Having no other coloured glass at hand to push these particular inquiries farther, I now removed the candles, and opening two holes in the upper parts of the window-shutters of two neighbouring windows, I let into the room from above two beams of light from different parts of the heavens, and placing the instrument in such a manner that two distinct shadows were projected by the cylinder upon the paper, I was entertained by a succession of very amusing appearances. The shadows were tinged with an infinite variety of the most unexpected, and often most beautiful colours, which continually varying, sometimes slowly, and sometimes with inconceivable rapidity, absolutely fascinated the eyes, and commanding the most eager attention, afforded an enjoyment as new as it was bewitching. It was a windy day, with flying clouds, and it seemed as if every cloud that passed brought with it another complete succession of varying hues, and most *harmonious* tints. If any colours could be said to predominate it was purples; but

all the varieties of browns, and almost all the other colours I ever remembered to have seen, appeared in their turns, and there were even colours which seemed to me to be perfectly new.

Reflecting upon the great variety of colours observed in these last experiments, many of which did not appear to have the least relation to the apparent colours of the light by which they were produced, I began to suspect that the colours of the shadows might, in many cases, notwithstanding their apparent brilliancy, be merely an optical deception, owing to contrast, or to some effect of the other neighbouring colours upon the eye. To determine this fact by a direct experiment, I proceeded in the following manner. Having, by making use of a flat ruler instead of the cylinder, contrived to render the shadows much broader, I shut out of the room every ray of daylight, and prepared to make the experiment with two ARGAND's lamps, well trimmed, and which were both made to burn with the greatest possible brilliancy; and having assured myself that the light they emitted was precisely of the same colour, by the shadows being perfectly colourless which were projected upon the white paper, I directed a tube about 12 inches long, and near an inch in diameter, lined with black paper, against the centre of one of the broad shadows; and looking through this tube with one eye, while the other was closed, I kept my attention fixed upon the shadow, while an assistant repeatedly interposed a sheet of yellow glass before the lamp whose light corresponded to the shadow I observed, and as often removed it. The result of the experiment was very striking, and fully confirmed my suspicions

with respect to the fallacy of many of the appearances in the foregoing experiments. So far from being able to observe any change in the shadow upon which my eye was fixed, I was not able even to tell when the yellow glass was before the lamp, and when it was not; and though the assistant often exclaimed at the striking brilliancy and beauty of the blue colour of the very shadow I was observing, I could not discover in it the least appearance of any colour at all. But as soon as I removed my eye from the tube, and contemplated the shadow with all its neighbouring accompaniments, the other shadows rendered *really* yellow by the effect of the yellow glass, and the white paper which had likewise from the same cause acquired a yellowish hue, the shadow in question appeared to me, as it did to my assistant, of a beautiful blue colour. I afterwards repeated the same experiment with the apparently blue shadow produced in the experiment with daylight and candle-light, and with exactly the same result.

How far these experiments may enable us to account for the apparent blue colour of the sky, and the great variety of colours which frequently adorn the clouds, as also what other useful observations may be drawn from them, I leave to philosophers, opticians, and painters to determine. In the mean time, I believe it is a new discovery, at least it is undoubtedly a very extraordinary fact, that the eyes are not always to be believed, *even with respect to the presence or absence of colours.*

I cannot finish this letter without mentioning one circumstance, which struck me very forcibly in all these experiments upon coloured shadows, and that is, the most perfect harmony

which always appeared to subsist between the colours, whatever they were, of the two shadows; and this harmony seemed to me to be full as perfect and pleasing when the shadows were of different tints of brown, as when one of them was blue and the other yellow. In short, the harmony of these colours was in all cases not only very striking, but the appearances were altogether quite enchanting; and I never found any body to whom I showed these experiments whose eyes were not fascinated with their bewitching beauties. It is, however, more than probable, that a great part of the pleasure which these experiments afforded to the spectators arose from the continual changes of colour, tint, and shade, with which the eye was amused, and the attention kept awake. We are used to seeing colours fixed and unalterable, hard as the solid bodies from which they come, and just as motionless, consequently dead, uninteresting, and tiresome to the eye; but in these experiments all is motion, life, and beauty.

It appears to me very probable, that a further prosecution of these experiments upon coloured shadows may not only lead to a knowledge of the real nature of the harmony of colours, or the peculiar circumstances upon which that harmony depends; but that it may also enable us to construct instruments for producing that harmony, for the entertainment of the eyes, in a manner similar to that in which the ears are entertained by musical sounds. I know that attempts have already been made for that purpose; but when I consider the means employed, I am not surprised that they did not succeed. Where the flowing tide, the varying swell, the *crescendo* is wanting, colours must ever remain hard, cold, and inanimate masses.

I am very sorry that my more serious occupations do not at present permit me to pursue these most entertaining inquiries. Perhaps at some future period I may find leisure to resume them.

Munich,
1st March, 1793.

I am, &c.

XI. *Investigations, founded on the Theory of Motion, for determining the Times of Vibration of Watch Balances.* By George Atwood, *Esq. F. R. S.*

Read February 27, 1794.

INSTRUMENTS for measuring time by vibratory * motion were invented early in the sixteenth † century: the single pendulum ‡ had been known to afford a very exact measure of time long before this period; yet it appears from the testimony of historical accounts, as well as other evidences, that the balance was universally adopted in the construction of the first clocks and watches; nor was it till the year 1657 that Mr. HUYGENS united pendulums with clock-work.

The first essays of an invention, formed on principles at once new and complicated, we may suppose were imperfectly executed. In the watches of the early constructions, some of

* The ancients, as early as 140 years before CHRIST (probably much earlier) were acquainted with the use of wheel-work in constructing instruments for measuring time. "Denticuli alius alium impellentes, versationes modicas faciunt ac motiones," is the expression of VITRUVIUS in describing a machine, one of the principal uses of which was to indicate the hour of the day. Vibrations are no where mentioned or alluded to in the descriptions of the clocks constructed by the ancients. Dr. DERHAM on Clock-work, p. 86, 4th edit.

† About the year 1500, according to some accounts.

‡ TYCHO BRAHE is supposed to have used the pendulum in astronomical observations. RICCIOLUS, KIRCHER, MERSENNUS, and many others, are expressly mentioned by STURMIUS to have employed this method of measuring time.

which are still preserved, the balance vibrated merely by the impulses of the wheels, without other control or regulation: the motion communicated to the balance by one impulse continued till it was destroyed, partly by friction, and partly by a succeeding impulse in the opposite direction; the vibrations must of course have been very unsteady and irregular.

These imperfections were in a great measure remedied by Dr. HOOKE's ingenious invention of applying a spiral spring to the balance: * the action of this spring on the balance of a watch, is similar to that of gravity on a pendulum: each kind of force has the effect of correcting the irregularities of impulse and resistance, which otherwise disturb the isochronism of the vibrations.

During the present century, various improvements have been made in the construction of watches, principally by the artists of this country, to whose ingenuity and skill, aided and encouraged by public rewards, we must attribute the excellence of the modern watches and time-keepers, so highly valuable for their uses in geography, navigation, and astronomy.

The principles on which time-keepers are constructed, considered in a theoretical view, afford an interesting subject of investigation. It is always satisfactory to compare the motion of machines with the general laws of mechanics, whenever friction and other irregular forces are so far diminished as to allow of a reference to theory; especially if inferences, likely to be of practical use, may be derived from such comparison.

* Anno 1658.—An inscription on a balance-spring watch, presented to King CHARLES II. fixes the date of this invention to the year 1658. Dr. DERHAM relates, that he had seen the watch, on which the following inscription was engraved: "ROBERT HOOKE inven. 1658. T. TOMPION fecit, 1675." Dr. DERHAM on Clockwork, p. 103.

In time-keepers, the irregular forces, both of impulse and resistance, are much diminished by the exactness of form and dimension which is given to each part of the work; and they are further corrected by the maintaining power derived from the main spring: for whatever motion is lost by the balance from resistance of any kind, almost the same motion is communicated by the maintaining power, so as to continue the arc of vibration, as nearly as possible, of the same length.

In these machines, the real measure of time is the balance, all the other work serving only to continue the motion of the balance, and to indicate the time as measured by its vibrations. The regularity of a time-keeper will therefore depend on that of the time in which the balance vibrates: to investigate this time of vibration, from the several data or conditions on which it depends, is the object of the ensuing pages.

Let PMNS (Tab. XIV. fig. 1.) represent the circumference of a watch balance, which vibrates by the action of a spiral * spring, on an axis passing through the centre C. Let ODBE be the circumference of a concentric circle, considered as fixed, to which the motion of the balance may be referred. In the circumference of this circle let any point O be assumed, and when the balance is in its quiescent position, suppose a line to be drawn through C and O, intersecting the circumference of the balance in the point A; the radius CA will be an index, by which the position of the balance, and its motion through any different arcs of vibration, will be truly defined. In the ensuing pages, the motion of the balance, and the motion of the index CA, will be used indifferently, as terms conveying

* In these investigations it is indifferent whether the balance is supposed to vibrate by the action of a spiral or helical spring.

the same meaning. Since the balance is in its quiescent position when the index C A is directed to the fixed point O, on this account O is called the point of quiescence of the balance, or balance spring, indicating the position when the balance is not impelled by the spring's elastic force either in one direction or the other. If the balance should be turned through any angle O C B, the spiral spring being wound through the same angle, endeavours by its elastic force to restore itself; and when at liberty, impels the balance through the arc B O with an accelerated velocity till it arrives at the position O, where the force of acceleration ceases; with the velocity acquired at O, the balance proceeds in its vibration, describing the arc O E with a retarded motion.

The elastic forces of the spring at equal distances on the opposite sides of the point O, are assumed to be equal; it is also assumed that the effects of friction, and other irregular resistances which retard the motion of the balance, are compensated by the maintaining power, so that the time of describing the first arc of vibration B O by an accelerated motion, shall be equal to the time of describing the latter arc O E by a retarded motion, and that the entire arc of vibration B O E is bisected by the point O.

To render the construction of fig. 1. more distinct, the fixed circle O D B E is represented to be at a small distance from the circumference of the balance, but is to be considered as coincident with it, so that the arc B O subtending the angle B C O, may be of the same length with an arc of the circumference of the balance which subtends the same angle B C O: on this principle C O or C A may be taken indifferently as the radius of the balance.

The determination of the time in which the balance vibrates, from the theory of motion, requires the following particulars to be known.

1st. The spring's elastic force, which impels the circumference of the balance when it is at a given angular distance O D (fig. 1.) from the quiescent point O.

2dly. The law or ratio observed in the variation of the spring's force, while the balance is impelled from the extremity of the semiarc B to the point of quiescence O, where all acceleration ceases.

3dly. The weight of the balance, including the parts which vibrate with it.

4thly. The radius of the balance C O, and the distance of the centre of gyration from the axis of motion C G.

5thly. The length of the semiarc B O.

Suppose the plane of the balance to be placed vertically, and let a weight P (fig. 2.) be applied by means of a line suspended freely from the circumference at T, to counterpoise the elastic force of the spring when the balance is wound through an angle from quiescence O C D. This weight P (the weight of the line being allowed for) will be the force of the spiral spring which impels the circumference of the balance, when at the angular distance O D, from the quiescent position.

It appears from many experiments, that the weights necessary to counterpoise a spiral spring's elastic force, when the balance is wound to the several distances from the quiescent point, represented* by the arcs OG, OH, OI, (fig. 2.) &c. are nearly in the ratio of those several arcs. It also appears, that the shape, the length, and number of turns of the spiral may be so adjusted

* Berthoud *Traité des Horloges marines*, p. 49.

to each other, that the forces of elasticity shall be counterpoised by weights which are in the precise ratio of the angular distances from the quiescent position, or, as it is sometimes expressed, in the ratio of the spring's tensions; at least as nearly as can be ascertained by experiment: this law of elastic force is assumed in the subsequent investigation.

The position of the centre of gyration may be always determined when the figure of the vibrating body is regular, by calculating the sum of the products which arise from multiplying each particle into the square of its distance from the axis of motion, and dividing the sum by the weight of the vibrating body; the square root of the result will be the distance of the centre of gyration from the axis of motion. When the figure of the vibrating body is irregular, recourse may be had to experimental * methods, in order to determine the position of the centre of gyration.

Let the radius of the balance CA or $CO = r$, (fig. 1.) the semiarc $BO = b$; let the spring's elastic force, acting on the circumference of the balance, when wound to any given angle OCD from the quiescent position be $= P$, and let the arc $OD = a$; the weight of the balance, and the parts which vibrate with it $= W$; the distance of the centre of gyration from the axis of motion $CG = g$. These notations being premised, the resistance of inertia by which the mass contained in the balance opposes the communication of motion to the circumference is $\frac{W g^2}{r^2}$: and consequently the force which accelerates the circumference at the angular distance OCD from the quiescent position is $\frac{P r^2}{W g^2}$. This quantity remaining invariably the same, while the balance describes the arc of vibration BOE, may be denoted by the letter F, so that

* Treatise on the Rectilinear Motion and Rotation of Bodies, p. 226 and 301.

$F' = \frac{P r^2}{W g^2}$; suppose the radius CA commencing a vibration from the point B to have described the arc B H, and let O H $= x$; since the force which accelerates the circumference at the angular distance from quiescence O D is $=$ F, and the forces of acceleration are supposed to vary in the proportion of the angular distances from the quiescent point O, the force which accelerates the circumference of the balance at the point H will be $= \frac{Fx}{a}$; let u be the space through which a body falls freely from rest by the acceleration of gravity to acquire the velocity of the circumference, at the point H; the principles of acceleration give this equation, * $\dot{u} = \frac{-Fx\dot{x}}{a}$;

* Newtonii Princ. Vol. I. prop. xxxix. Let a body describe the line A C by the acceleration of a force varying in any ratio of the distances from a centre C. Let another body describe the line E H by the acceleration of a constant or uniform force. Suppose the velocity at O to be equal to the velocity at D, and let O G and D F be the evanescent spaces, or increments of space in which equal velocities are generated; so that E D may represent a line through which a body must fall from rest by the acceleration of the constant or uniform force, to acquire the velocity of the other body at O. It is to be proved that the increment of space O G is to the increment of space D F, as the force of acceleration at D to the force of acceleration at O. Let the former of these forces, *i. e.* at D be denoted by G, and the latter force at O by H. Let E D $= u$, and let A O $= x$. Also let D F $= \dot{u}$, and O G $= \dot{x}$.

Because the increments of velocity are always as the forces of acceleration and the elementary times in which they act jointly, it follows, that when the increments of velocity are equal, the forces are in the inverse ratio of the elementary times in which they act; that is (the velocities of describing the evanescent spaces O G, D F being equal by the supposition), the forces are in the inverse ratio of those spaces; and consequently the force at D (G) is to the force at O (H) as O G to D F; that is, according to the preceding notation, G : H : : $\dot{x}$: $\dot{u}$ or $\dot{u} = \frac{H\dot{x}}{G}$. The constant force G being assumed equal to that of gravity, may be denoted by any constant quantity, such as unity. By substituting therefore 1 for G, the equation will become $\dot{u} = H\dot{x}$. In this

and taking the fluents while x decreases from b to x, $u = \frac{F \times \overline{b^2 - x^2}}{2a}$: if therefore l is made $= 193$ inches, being the space which bodies falling freely from rest by the force of gravity near the earth's surface describe in one second of time, the velocity of the circumference, when the extremity A of the index C A has arrived at the point H, will be

$$= \sqrt{\frac{2lF}{a}} \times \sqrt{b^2 - x^2}.$$

Let t represent the time in which the circumference describes the arc B H; then will $\dot{t} = \sqrt{\frac{a}{2lF}} \times \frac{-\dot{x}}{\sqrt{b^2 - x^2}}$; and $t = \sqrt{\frac{a}{2lF}} \times$ into a circular arc, of which the cosine $= \frac{x}{b}$ to radius $= 1$, which is the time of describing the arc B H expressed in parts of a second; when $x = 0$, that is when the circumference has described the entire semiarc B O, the circular arc of which the cosine $= \frac{x}{b}$ is a quadrant of a circle to radius $= 1$. Let $p = 3.14159$, &c. The time t, of describing the semiarc B O $= \sqrt{\frac{a}{2lF}} \times \frac{p}{2} = \sqrt{\frac{p^2 a}{8lF}}$.

In this expression for the time of a semivibration, the letter a denotes the length of the arc OD (fig. 1.); if this arc should be expressed by a number of degrees c°, a will then $= \frac{p r c^\circ}{180^\circ}$; and this quantity being substituted for a, the time of a semivibration will be $t = \sqrt{\frac{p^3 r c^\circ}{8lF \times 180^\circ}}$; if instead of F, its value $\frac{P r^2}{W g^2}$ is substituted in the equation $t = \sqrt{\frac{p^3 r c^\circ}{8lF \times 180^\circ}}$, the time of a semivibration will be $t = \sqrt{\frac{W p^3 g^2 c^\circ}{8 P r l \times 180^\circ}}$.

Let the given arc c° be $= 90^\circ$; in this case $t = \sqrt{\frac{W p^3 g^2}{16 P r l}}$.

expression the lines u and x are supposed to increase together; but if u increases while x decreases, the signs of the variations $\dot{u}$ and $\dot{x}$ will be contrary; in which case the equation will become $\dot{u} = -H\dot{x}$.

These are expressions for the time of a semivibration, whatever may be the figure of the balance, the other conditions remaining the same as they have been above stated. If the balance should be a cylindrical plate, it is known that the distance of the centre of gyration from the axis is to the radius as 1 to $\sqrt{2}$; wherefore in this case $g^2 = \frac{r^2}{2}$; and the time of a semivibration, or $t = \sqrt{\frac{W p^3 r}{32 P l}}$. *

* The balances of watches are usually of such a form as to place the centre of gyration nearly at the same distance from the axis, as if the figures were cylindrical plates of uniform thickness and density. If it should be required to obtain from theory the time of a balance's vibration precisely exact, it would be necessary to calculate rigidly the position of the centre of gyration from the dimensions of each part of the balance, and whatever vibrates with it. But in cases merely illustrative of the general theorems for ascertaining the times of vibration, it is unnecessary to enter into prolix and troublesome calculations depending on the form of any particular balance; since by assuming it as a cylindrical plate, the time of a vibration will not differ materially from that which would be the result of the correct investigation.

Being desirous of comparing the time of vibration, as deduced from the theory of motion, with the actual vibration of a watch balance, I requested Mr. Earnshaw (the excellent performance of whose time-keepers is well known) to make the experiments from which the necessary data for this calculation are derived. These experiments were made on the balance of a watch constructed by Mr. Kendal, on Mr. Harrison's principles, and is the instrument which Captain Cook took out with him during his last voyage to the South Seas. The results are underneath:

Diameter of the balance - - - - - $2\frac{1}{4}$ inches.

Weight of the balance, and parts which vibrate with it - - 42 grains.

Weight applied to the circumference of the balance, which counterpoises the force of the spiral spring when the balance is wound through an angle of 180° - - - - - - 48 grains.

The weight which counterpoises the spring's force when the balance is wound to 90 degrees from quiescence is - - - 24 grains.

These determinations give the following substitutions in the expression for the time of a semivibration $t = \sqrt{\frac{W p^3 r}{32 P l}}$.

It is observable that the semiarc of vibration B O $= b$, does not enter into these expressions for the time of a semivibration; if therefore instead of the semiarc B O, an arc of any other length LO, terminating in the point of quiescence O, (fig. 1.) should be substituted in the preceding investigation, the time of describing L O would be still $= \sqrt{\frac{a\,p^2}{8\,l\,F}}$ or $\sqrt{\frac{p^3\,r\,c^\circ}{8\,l\,F \times 180^\circ}}$ equal to the time of describing the other semiarc B O; consequently, whether the balance vibrates in the largest or smallest arcs, the times of vibration will be the same.

From the preceding investigations it appears, that when the force by which the circumference of the balance is accelerated at the given angular distance c° from the quiescent position is $=$ F, the time of a semivibration $t = \sqrt{\frac{p^3\,r\,c^\circ}{8\,l\,F \times 180^\circ}}$; and conversely, when the time of a semivibration is $= t$, the force which accelerates the circumference at the given angular distance c° from the quiescent position, that is $F = \frac{p^3\,r\,c^\circ}{8\,l\,t^2 \times 180^\circ}$.

Since watches and time-keepers are usually adjusted to

Namely, W $=$ 42 gr. $=$ the weight of the balance, including the parts which vibrate with it.

P $=$ 24 gr. $=$ the force at the circumference of the balance, which counterpoises the force of the spring when wound to the distance 90°.

$r = 1.125$ inch. and parts $=$ the radius of the balance.

$l = 193$ inches $=$ the space described in one second of time by bodies which descend freely from rest by the acceleration of gravity.

$p = 3.14159$, &c. $=$ the circumference of a circle of which the diameter $= 1$;

the time of a semivibration $t = \sqrt{\frac{42 \times \overline{3.14159}^3 \times 1.125}{32 \times 24 \times 193}} =$ pts. of a second. 0.0994

The balance, when adjusted to mean time, makes 5 vibrations in a second; the actual time of a semivibration is therefore - - 0.1000

Difference between the actual time and the time by the calculation - 0.0006

mean time when the balance makes 5 vibrations in a second, the time of a semivibration will in this case $= \frac{1}{10}$ part of a second: the substitution of $\frac{1}{10}$ for t being made in the preceding equation, the force which accelerates the circumference of the balance, when at any given angular distance c° from the quiescent position, will be determined for all time-keepers adjusted to mean time, in which the balances make 5 vibrations in a second. Suppose the given angle $c^\circ = 90^\circ$; then making $c^\circ = 90^\circ$, $p = 3.14159$, &c. $l = 193$, $t = \frac{1}{10}$, the accelerative force at the angular distance from quiescence 90° or $F = \frac{p^3 r 90^\circ}{8 l t^2 \times 180^\circ} = r \times 1.00408926$. We have therefore arrived at the following conclusion: if the radius of the balance is equal to 1 inch, and the time-keeper is adjusted to mean time when the balance makes 5 vibrations in a second, the force which accelerates the circumference of the balance at the distance of 90° from the quiescent position, is = 1.00408926, the accelerative force of gravity being = 1. And if the radius of the balance is greater or less than 1 inch, the force by which the circumference is accelerated at the distance of 90° from quiescence, will be greater or less than 1.00408926 in proportion to the radii.

According to the principles assumed in the preceding solution, the spring's elastic force is supposed to vary in the proportion of the angular distances from the quiescent position, and on this condition, the vibrations are shewn to be isochronous, whether they are performed in longer or shorter arcs; but if the spring's elastic force at different distances from quiescence should not be precisely in the ratio here assumed, the longer and shorter arcs may be described in times differing in any proportions of inequality. If, for instance, the spring's

force, instead of varying in the ratio of the aforesaid distances, should vary in the $\frac{999}{1000}$ power, or $\frac{1001}{1000}$ power of the distances, it does not appear from the preceding solution what alteration in the daily rate would be caused by this change in the law of the force's variation, when the semiarc of vibration is increased or diminished by a given arc. To ascertain this point fully, other researches will be necessary, by which it may be known, what alteration of the daily rate of a time-keeper is occasioned by a given increase or diminution of the arc of vibration, when the spring's elastic force varies in a ratio of the distances from the quiescent position, the general index or exponent of which is any number or fraction n.

The force which accelerates the balance being assumed in that power of the distances the exponent of which is n, let $BO = b$ (fig. 3.) be the semiarc of vibration when the time-keeper is adjusted to mean time; let $DO = a$; the accelerating force on the circumference at the distance from quiescence $OD = F$; suppose the circumference to have described the arc BH from the extremity of the arc B; and let $HO = x$: then the force by which the circumference is accelerated when at the angular distance from the quiescent position $OH = \frac{F x^n}{a^n}$; let u be the space through which a body falls freely from rest by the acceleration of gravity, to acquire the velocity of the circumference when it has described the arc BH; the principles of acceleration give this equation:

$\dot{u} = \frac{-F x^n \dot{x}}{a^n}$: taking the fluents while x decreases from b to x,

$u = \frac{F b^{n+1} - F x^{n+1}}{\overline{n+1} \times a^n}$, and l being 193 inches, the velocity acquired by the circumference after describing BH, will be

$$= \sqrt{\frac{4lF}{n+1 \times a^n}} \times \sqrt{b^{n+1} - x^{n+1}};$$

let T be the time of describing the arc B H; wherefore

$$\dot{T} = \sqrt{\frac{n+1 \times a^n}{4lF}} \times \sqrt{\frac{-\dot{x}}{b^{n+1} - x^{n+1}}}.$$

The time of describing the arc B H will be the fluent of this fluxion, while x decreases from b to x, and the time of describing the semiarc B O will be the entire fluent of $\sqrt{\frac{n+1 \times a^n}{4lF}} \times \sqrt{\frac{-\dot{x}}{b^{n+1} - x^{n+1}}}$, while x decreases from b to o.

Now let the balance commence its vibration from any other point I, (fig. 3.) and let I O $= c$; suppose the circumference to have described the arc I K, and make O K $= y$; let t be the time of describing the arc I K; then by proceeding in the same manner as in the former case, it is found that $\dot{t} = \sqrt{\frac{n+1 \times a^n}{4lF}} \times \sqrt{\frac{-\dot{y}}{c^{n+1} - y^{n+1}}}$; and the time of describing the semiarc I O, will be the entire fluent of this fluxion, while y decreases from c to o. Although the fluents of the fluxions $\sqrt{\frac{-\dot{x}}{b^{n+1} - x^{n+1}}}$ and $\sqrt{\frac{-\dot{y}}{c^{n+1} - y^{n+1}}}$ cannot be expressed in general terms, yet the exact proportion of the said fluents may be assigned, which will be the proportion of the times in which the balance vibrates in the two semiarcs B O, I O; the multiplying quantity $\sqrt{\frac{n+1 \times a^n}{4lF}}$ being common to both fluxions; and since the entire fluent * of $\sqrt{\frac{-\dot{x}}{b^{n+1} - x^{n+1}}}$ is to the entire fluent of

* $\sqrt{\frac{\dot{x}}{b^{n+1} - x^{n+1}}} = \frac{1}{b^{\frac{n+1}{2}}} \times \sqrt{\frac{\dot{x}}{1 - \frac{x}{b}^{n+1}}}$

$\frac{-\dot{y}}{\sqrt{c^{n+1}-y^{n+1}}}$ as $b^{\frac{1-n}{2}}$ is to $c^{\frac{1-n}{2}}$, it follows, that the time of a semivibration in the arc B O is to the time of a semivibration in the arc I O, as $b^{\frac{1-n}{2}}$ to $c^{\frac{1-n}{2}}$, or as 1 to $\left|\frac{IO}{BO}\right|^{\frac{1-n}{2}}$.

Suppose a watch to be adjusted to mean time when the semiarc of the balance's vibration is = B O (fig. 3.) and let this semiarc be afterwards diminished to I O; the time shewn by the watch in any given portion of mean time t, when the semiarc of vibration is I O, will be $= t \times \left|\frac{BO}{IO}\right|^{\frac{1-n}{2}}$; and if t is put $= 24^h$, the alteration of the daily rate, in consequence of the dimi-

and $\sqrt{\frac{\dot{y}}{c^{n+1}-y^{n+1}}} = \frac{1}{c^{\frac{n+1}{2}}} \times \sqrt{\frac{\dot{y}}{1-\left|\frac{y}{c}\right|^{n+1}}}$.

To find the proportion of the entire fluent of $\sqrt{\frac{\dot{x}}{1-\left|\frac{x}{b}\right|^{n+1}}}$ to the entire fluent of $\sqrt{\frac{\dot{y}}{1-\left|\frac{y}{c}\right|^{n+1}}}$

make $x = \frac{by}{c}$, so that when $x = 0$, $y = 0$, and when $x = b$, $y = c$;

then $\sqrt{\frac{\dot{x}}{1-\left|\frac{x}{b}\right|^{n+1}}} = \frac{b}{c} \times \sqrt{\frac{\dot{y}}{1-\left|\frac{y}{c}\right|^{n+1}}}$,

and the proportion of $\sqrt{\frac{\dot{x}}{1-\left|\frac{x}{b}\right|^{n+1}}}$ to $\sqrt{\frac{\dot{y}}{1-\left|\frac{y}{c}\right|^{n+1}}}$ will be equal to that of $\frac{b}{c}$ to 1, or of b to c; this being the constant proportion of the fluxions when $x = \frac{by}{c}$; the fluents will be in the same proportion, provided $x = \frac{by}{c}$; wherefore the entire fluent of $\sqrt{\frac{\dot{x}}{b^{n+1}-x^{n+1}}}$ will be to the entire fluent of $\sqrt{\frac{\dot{y}}{c^{n+1}-y^{n+1}}}$ as $\frac{\frac{b}{b^{\frac{n+1}{2}}}}{\frac{c}{c^{\frac{n+1}{2}}}}$; or as $b^{\frac{1-n}{2}}$ to $c^{\frac{1-n}{2}}$.

nution of the semiarc of vibration from B O to I O, will be $24^h \times \overline{\frac{BO}{IO}}^{\frac{1-n}{2}} - 1$.*

To apply this proposition, let a case be assumed; suppose a watch to be regulated to mean time when the semiarc of vibration is 135°, and let this semiarc be diminished 8°, so as to become 127°; let the ratio of the spring's elastic

* From this general expression it appears, that when $n = 1$, that is when the spring's elastic force varies in the precise ratio of the angular distances of the balance from the quiescent position, the alteration of the daily rate in consequence of a diminution of the arc of vibration is $= 0$; because in that case $\overline{\frac{BO}{IO}}^{\frac{1-n}{2}} = 1$, and $\overline{\frac{BO}{IO}}^{\frac{1-n}{2}} - 1 = 0$. When n is less than 1, or when the force varies in a less ratio than that of the distances from quiescence, the rate will be accelerated, because in that case $\overline{\frac{BO}{IO}}^{\frac{1-n}{2}}$ will be greater than 1; and $\overline{\frac{BO}{IO}}^{\frac{1-n}{2}} - 1$, will be a positive quantity: but when n is greater than 1, or when the force varies in a ratio greater than that of the distances from quiescence, the rate will be retarded, because in that case $\overline{\frac{BO}{IO}}^{\frac{1-n}{2}}$ will be less than 1, and $\overline{\frac{BO}{IO}}^{\frac{1-n}{2}} - 1$ becomes negative. The converse of these propositions is likewise derived from the general theorem.

Whenever therefore it is found, by observing the rate of a time-keeper, that a diminution of the arc of the balance's vibration causes an acceleration of the daily rate, it is necessary to conclude, that the elastic force of the spring in this case varies in a ratio less than that of the distances from the quiescent position. In like manner, when a diminution of the arc of vibration causes a retardation of the rate, it is certain that the spring's elastic force varies in a higher ratio than that of the distances from quiescence. It appears, indeed, from some experiments, that the weights which counterpoise a spiral spring's elastic force, when wound to different distances from the quiescent position, are in the ratio of those distances; but it is shewn from this proposition, and the annexed table, that the differences between the weights, by which the ratio of the distances, and a ratio a little less is indicated, although far too small to be discoverable by experiment, are yet sufficient to create a material alteration of the daily rate.

force deviate from that of the distances from the quiescent position by a small difference of $\frac{1}{1000}$ part, so that the spring's force shall be in the $\frac{999}{1000}$ power of the distances, instead of in the entire ratio of the said distances from the quiescent position. The alteration in the daily rate of the watch will be obtained from the preceding theorem by making the following substitutions. $BO = 135°$, $IO = 127°$, $n = \frac{999}{1000}$: the alteration of the daily rate $= 24^h \times \overline{\frac{135}{127}|^{\frac{1}{1000}} - 1} =$ $+ 2''.62$.

It here appears, that a very minute alteration in the law of the force's variation, amounting to no more than $\frac{1}{1000}$ part of the entire ratio of the distances, causes an acceleration in the daily rate of more than $2\frac{1}{2}''$, when the diminution of the semiarc of vibration is 8°. It may therefore be of some use to inquire, what are the differences of the weights to be observed in experiments from which the law of the spring's elastic force is derived; first, supposing that law to be the precise ratio of the distances from the quiescent position; and secondly, supposing the law of the force to deviate from that ratio by a small difference of $\frac{1}{1000}$, so as to become the $\frac{999}{1000}$ power of the distances from the quiescent position; from the result a judgment may be formed how far experiments may be relied on for ascertaining the precise law according to which the elastic force of a spring varies.

Values of x°.	Values of $P = 9\text{gr.} \times \frac{x^\circ}{90^\circ}$	Values of $P = 9\text{gr.} \times \left(\frac{x^\circ}{90^\circ}\right)^{\frac{999}{1000}}$
Angular distances from the quiescent position when the spring's elastic force is counterpoised by the weights in the second and third columns. (Fig. 2).	Weights P, expressed in grains, which counterpoise the spring's elastic force when wound to the several distances from the quiescent position in the first column, if the force varies in the precise ratio of the angular distances from the quiescent point.	Weights P, expressed in grains, which counterpoise the spring's elastic force when wound to the several distances from quiescence in the first column, if the force varies in the $\frac{999}{1000}$ power of the distances from the quiescent point.*
	Grains.	Grains.
10°	1	1.002199
20°	2	2.003010
30°	3	3.003298
40°	4	4.003245
50°	5	5.002940
60°	6	6.002433
70°	7	7.001759
80°	8	8.000942
90°	9	9.000000

The differences of weights expressed in the second and third columns of this table are evidently too small to admit of being observed experimentally, and yet their effect on the daily rate of a time-keeper amounts to a quantity far from insensible. This effect on the rate might probably be augmented to twenty or thirty seconds daily, and yet the corresponding differences of weights arising from the deviation of the spring's force from the law of isochronism might be too minute to become sensible by any statical counterpoise of the spring's forces; and it would

* It may be here observed, that the differences of the weights in the second and third columns of the table, first increase and afterwards decrease; their difference is the greatest when the quantity $9 \times \left(\frac{x}{90}\right)^{\frac{999}{1000}} - \frac{9x}{90}$ is a maximum; or when $x = 90^\circ \times \left(\frac{999}{1000}\right)^{1000}$, that is when $x = 33^\circ\ 5'\ 33''$.

be still less possible to measure the said differences of weights with the exactness required for the determination of the law observed by the spring's forces. Experiments of this kind should not therefore be absolutely relied on for ascertaining practically the isochronal property of spiral springs, although this property must be allowed to exist in theory, whenever the forces of elasticity at the several angular distances from the quiescent position are in the precise ratio of those distances. The isochronal law of variation, here mentioned, may be conveniently assumed in theoretical investigations, and proper corrections or equations, when necessary, may be applied to compensate for the deviation from this law, which may subsist in any particular spiral spring, whenever it can be satisfactorily ascertained, or reduced within known limits, by such mode of inference as the nature of the case may admit of. This assumption will appear the less exceptionable from considering, that the elastic forces of spiral springs which are not isochronal deviate from the law of variation in question, in some cases by exceeding, and in others, by falling short of it; and no other law is suggested either by theory or experiment, which more generally corresponds with the action of balance springs.

The vibration of a balance impelled by a single spiral spring only, has been the subject of the preceding investigations; but cases occur in which two or more springs are employed in giving vibratory motion to the balances of watches. Not to mention preceding instances, Mr. MUDGE, an eminent watch-maker of the present times, has invented a method of combining the action of spiral springs, to impel the balance in each semiarc of vibration, on a principle not more remarkable for the novelty than it is for the ingenuity of the contrivance. The consideration of this additional case will therefore not be

thought foreign to the present subject, especially as it may contribute to elucidate some circumstances respecting the effect of springs on the vibrations of balances, which at the first view are not at all obvious.

Let two spiral springs be applied to act on a watch balance in the same direction; if the two springs in unwinding themselves, by turning the balance come to the same point of quiescence, or, in other words, if the accelerative forces of both springs cease at the middle point of the vibration, whatever be the relative strength of the two springs, they will act on the balance precisely in the same manner as if one spring only had been applied, of equal strength with both (the springs being here supposed similar, in respect of the law of the elastic forces and tensions). But when the points of quiescence of the two springs do not coincide, that is, when one spring continues to accelerate the balance in its vibration, after the acceleration of the other spring has ceased, the time of a semivibration must be obtained from a separate investigation.

Let the circumference of a balance (fig. 4.) be impelled by the action of a spiral spring through the semiarc of vibration B O, the forces of this spring being always in proportion to the angular distances from the point of quiescence O; let a secondary or auxiliary spring also act on the balance from the extremity of the semiarc B as far as the point Q, at which point all acceleration of the auxiliary spring ceases, the forces of the auxiliary spring varying as the angular distances from the point of quiescence Q. Suppose that the accelerative force of the principal or balance spring on the circumference of the balance at the distance from quiescence O D is $=f$, take Q d = O D, and let the accelerative force of the balance spring on the circumference of the balance be to that of the auxiliary spring, when both springs are wound to

the same angle O C D = Q C d, in the proportion of 1 to n; then the accelerative force of the auxiliary spring at the angular distance from quiescence Q d will $= nf$; let B O = b, B Q = c, Q O = $d = b - c$; also let O D or Q $d = a$.

Suppose the balance to have described the arc B H by the joint action of both the springs, and let the arc B H be represented by x. Then, because the accelerative force of the principal or balance spring at the angular distance from quiescence O D = a is f, the accelerative force of the same spring at the distance O H is $= \frac{f \times \overline{b-x}}{a}$; and since the force of the auxiliary spring at the angular distance from quiescence Q $d = a$ is nf, the accelerative force of this spring at the angular distance from quiescence Q H will be $= \frac{nf \times \overline{c-x}}{a}$; wherefore the joint force of both springs to accelerate the circumference when at the distance O H from the point of quiescence O, that is, when the balance has described the arc B H, will be $= \frac{f}{a} \times \overline{b-x+cn-nx}$. Let u be the space through which a body falls freely from rest by the acceleration of gravity, to acquire the velocity of the circumference when it has described the arc B H; this will give the following equation:

$\dot{u} = \frac{f}{a} \times \overline{b\dot{x} - x\dot{x} + cn\dot{x} - nx\dot{x}}$; and

$u = \frac{f}{2a} \times \overline{2bx - x^2 + 2cnx - nx^2}$; and if $l = 193$ inches, the velocity of the circumference when the arc B H has been described, is $= \sqrt{\frac{2lf}{a}} \times \sqrt{2bx - x^2 + 2cnx - nx^2}$. Let t represent the time in which the balance describes the arc B H; then $\dot{t} = \sqrt{\frac{a}{2lf}} \times \frac{\dot{x}}{\sqrt{2bx - x^2 + 2cnx - nx^2}}$ and the fluent

or $t = \sqrt{\frac{2a}{lf \times n+1}} \times$ into a circular arc of which the sine is

$\sqrt{\frac{x \times n+1}{2b+2nc}}$ to radius $= 1$; which is the time of describing the arc B H. When $x = c$, the time of describing the arc B Q, is $\sqrt{\frac{2a}{lf \times n+1}} \times$ into a circular arc of which the sine $= \sqrt{\frac{c \times n+1}{2b+2nc}}$.

The time of describing the remaining part of the semiarc Q O, (fig. 4.) is next to be determined. In the cases to which this investigation is applied, the auxiliary spring ceases entirely to act on the balance after it has described the arc B Q. This being stated, while the balance describes the remaining arc of the semivibration Q O, it will be impelled by the balance spring only. To ascertain the time of describing the arc Q O, it is first to be observed, that when the circumference has described the arc B Q, it will have acquired a velocity equal to that of a body which has fallen from rest by the acceleration of gravity through a space* $= \frac{f}{2a} \times \overline{2bc - c^2 + nc^2}$.

Suppose the balance to have proceeded through the arc Q R, (fig. 4.) and let O R $= x$; the force by which the circumference is accelerated at R $= \frac{fx}{a}$; and if u is the space through which a body falls freely from rest by the acceleration of gravity to acquire the velocity of the circumference in the point R, $\dot{u} = \frac{-f\dot{x}x}{a}$; taking the fluents so that u may become $= \frac{f}{2a} \times \overline{2bc - c^2 + nc^2}$ when $x = d$, $u = \frac{f}{2a} \times \overline{2bc - c^2 + nc^2 + d^2 - x^2}$; or because $d^2 = b^2 - 2bc + c^2$; $u = \frac{f}{2a} \times \overline{b^2 + nc^2}$

* When the circumference has described the arc B H $= x$, it will have acquired a velocity equal to that of a body which has fallen freely from rest by the acceleration of gravity through a space $= \frac{f}{2a} \times \overline{2bx - x^2 + 2cnx - nx^2}$, as appears from the investigation in page 138; and when $x = c$, this space becomes $= \frac{f}{2a} \times \overline{2bc - c^2 + 2c^2n - nc^2} = \frac{f}{2a} \times \overline{2bc - c^2 + nc^2}$.

$\sqrt{-x^2}$; and the velocity of the circumference at R (fig. 4.) $=$ $\sqrt{\frac{2lf}{a}} \times \sqrt{b^2 + nc^2 - x^2}$: let t be the time of describing QR; then $\dot{t} = \sqrt{\frac{a}{2lf}} \times \frac{-\dot{x}}{\sqrt{b^2 + nc^2 - x^2}}$, and $t = \sqrt{\frac{a}{2lf}} \times$ into a circular arc of which the cosine is $\frac{x}{\sqrt{b^2 + nc^2}}$ to radius $= 1$, which should $= o$ when $x = d$; wherefore t or the time of describing $QR = \sqrt{\frac{a}{2lf}} \times$ into a circular arc of which the cosine is $\frac{x}{\sqrt{b^2 + nc^2}} - \sqrt{\frac{a}{2lf}} \times$ into a circular arc of which the cosine is $\frac{d}{\sqrt{b^2 + nc^2}}$; and when $x = o$, that is when the entire arc QO has been described, the time $t = \sqrt{\frac{a}{2lf}} \times$ into a circular arc of which the sine is $\frac{d}{\sqrt{b^2 + nc^2}}$.

The result of this investigation is, that the time in which the balance describes the semiarc BO, by the joint action of both springs through the arc BQ, and by the action of the balance spring only through the arc QO,

is $= \sqrt{\frac{2a}{lf \times \overline{n+1}}} \times$ an arc, of which the sine is $\sqrt{\frac{c \times \overline{n+1}}{2b + 2nc}}$

$+ \sqrt{\frac{a}{2lf}} \times$ an arc, of which the sine is $\frac{d}{\sqrt{b^2 + nc^2}}$

(to radius $= 1$) expressed in parts of a second.*

* When $n = o$, this expression becomes $\sqrt{\frac{a}{2lf}} \times$ twice an arc, of which the sine is $\sqrt{\frac{c}{2b}}$ + an arc, of which the sine is $\frac{d}{b}$: but since $c = b - d$, the two arcs here mentioned will be exactly $= 90° = \frac{p}{2}$; and the time of a semivibration $= \sqrt{\frac{a}{2lf}} \times \frac{p}{2} = \sqrt{\frac{ap^2}{8lf}}$, agreeing with the solution in page 126. Suppose $d = o$; since in this case $b = c$, the time of a semivibration becomes $\sqrt{\frac{2a}{lf \times \overline{n+1}}} \times$ an arc, of which the sine is $\sqrt{\frac{b}{2b}}$ which arc is $= 45°$, or $\frac{p}{4}$; wherefore the time of a semivibration in this case $= \sqrt{\frac{ap^2}{8lf \times \overline{n+1}}}$, which is the true value, according to the solution in page 126. See also page 146.

This solution is confined to that case in which the point of quiescence Q (fig. 4.) of the auxiliary spring is situated in the first semiarc of the vibration, that is, between B and O. Another case still remains to be considered, which is, when the point of quiescence Q of the auxiliary spring deviates from O by the given angular distance O Q, but is situated in the latter semiarc of the vibration (fig. 5.), between O and E, instead of between O and B, as in the former solution. According to this condition, making B Q = c, B O = b, and the other notation remaining as before, it appears from an investigation no ways differing from the preceding, that the time in which the balance describes the semiarc B O will be

$t = \sqrt{\frac{2a}{lf \times \overline{n+1}}}$ × into a circular arc, of which the sine is $\sqrt{\frac{b \times \overline{n+1}}{2b + 2nc}}$ expressed in parts of a second.

This result expresses the time in which the balance describes the semiarc B O, (fig. 5.) by the accelerative force of two springs, namely, the balance spring, of which the point of quiescence is O, and an auxiliary spring, of which the point of quiescence is Q. On considering this case more fully, when applied to the actual vibrations of a balance, it will appear evident, that the action of a third spring on the balance while it is describing the semiarc B O, must be taken into the calculation, in addition to the two springs already mentioned, in order to obtain a solution entirely correspondent with the circumstances of the case, when the points of quiescence of the auxiliary springs are situated in the latter semiarcs of the vibrations.

To state this more clearly, it is to be observed, that when the points of quiescence of the balance and auxiliary springs

are coincident; the auxiliary spring commencing its action from the extremity B of the arc B O, (fig. 6.) continues to accelerate the balance till it arrives at the quiescent position O, at which point the action of the auxiliary spring entirely ceases; on this account it is plain that another auxiliary spring, equal and similar to the former, having also the point of quiescence coincident with O, must be applied to act by retardation on the balance while it describes the arc O E, in order that the times of describing the arcs BO and OE, as well as these arcs themselves, may be equal. According, therefore, to this disposition of the auxiliary springs, the balance will describe each semiarc of its vibrations precisely in the same manner as if it was impelled by one spiral spring only, the strength of which is equal to that of the balance and either auxiliary spring, when wound to the same tension. Suppose the balance to vibrate from B to E, and, for the sake of distinction, let the auxiliary spring which accelerates the balance from the extremity of the arc B, in the direction B O, be called *u*; and let the other auxiliary * spring which retards the balance in the semiarc O E be denoted by *v*; consequently, when the balance vibrates in the contrary direction from E to B, the auxiliary spring *v* will accelerate the balance from E to O, and the other auxiliary spring *u* will retard it from O to B. In respect, therefore, to the spring *u*, B O is the first semiarc, and O E is the latter semiarc of vibration; and on a similar principle in respect to the spring *v*, E O is the first semiarc, and O B is the latter semiarc of vibration.

* The circular arcs which are drawn interior to the circumference of the balance in the figures 4, 5, and 6, are intended to represent those portions of the balance's vibration in which the auxiliary springs respectively act.

In the preceding pages, the time has been investigated in which a balance vibrates in the semiarc B O, (fig. 4.) when the point of quiescence Q, of the auxiliary spring *u*, is situated between B and O, that is in the first semiarc of vibration. In this case, in order that the time of describing the latter semiarc O E, by retardation, may be equal to that of describing the first semiarc B O by accelerated motion, the quiescent point of the auxiliary spring *v* must be placed at N, between O and E, so that E N may be equal to B Q; according to this disposition of the auxiliary springs, the point of quiescence Q of the auxiliary spring *u* will be situated in the first semiarc of vibration, considering the balance as vibrating from B to E; and the point of the quiescence N of the auxiliary spring *v*, will be in the first semiarc of vibration, considering the balance as vibrating from E to B.

The third case which remains to be more fully investigated is, when the points of quiescence of the auxiliary springs are situated in the latter semiarcs of the respective vibrations; that is, when the quiescent point Q of the auxiliary spring *u* is situated in the latter arc O E, (fig. 5.) while the balance vibrates from B to E, and the point of quiescence N of the auxiliary spring *v* is situated in the latter arc O B, while the balance vibrates from E to B. In this case it is evident, that while the balance vibrates from B to O, it describes the arc B N by the acceleration of two springs; namely, the balance spring, of which the point of quiescence is O, and the auxiliary spring *u*, of which the point of quiescence is Q. And the balance describes the arc N O by the combined action of three springs; namely, by that of the balance spring, of which the point of quiescence is O, that of the auxiliary spring *u*, of

which the point of quiescence is Q, both of which accelerate the balance, and that of the auxiliary spring *v*, of which the point of quiescence is N, acting by retarding the balance.

The time in which the balance describes the semiarc B O, by the combined action of these three springs, will be obtained by the following investigation.

Resuming the former notation, let D O (fig. 5.) $= a =$ Q *d* $=$ N *e*, B O $= b$, B Q $= c$, O Q $=$ O N $= d = c - b$. The accelerative force of the balance spring on the circumference of the balance at the tension O D $= f$; the accelerative force of the auxiliary springs at the same tension Q *d* or N *e* $= nf$. From page 138 and 139, it appears that the time in which the balance describes the arc B N by the joint action of the balance spring and auxiliary spring $u = \sqrt{\frac{2a}{lf \times \overline{n+1}}}$ × a circular arc of which the sine $= \sqrt{\frac{b-d \times \overline{n+1}}{2b+2nc}}$; and the velocity acquired by the circumference at N is equal to that of a body which has fallen freely from rest by the acceleration of gravity through a space* $= \frac{f}{2a} \times \overline{b^2 - d^2 + nb^2 - 3nd^2 + 2nbd}$. To find the time of describing the arc N O, suppose the balance to have proceeded in its vibration from N to R, (fig. 5.) and make N R $= x$.

* In the investigation, page 138, it is shewn, that when the balance has described the arc B H $= x$, the space through which a body must fall freely from rest to acquire the velocity of the circumference at the point H, or $u = \frac{f}{2a} \times \overline{2bx - x^2 + 2cnx - nx^2}$, the expression being the same, whether the point Q is on one side of O or on the other, provided B Q $= c$. In the present case, $c = b + d$, and when the circumference has described the arc B N, $x = b - d$; wherefore if $b + d$ is substituted for c, and $b - d$ for x in the equation, $u = \frac{f}{2a} \times \overline{2bx - x^2 + 2cnx - nx^2}$, the result will be $u = \frac{f}{2a} \times \overline{b^2 - d^2 + nb^2 - 3nd^2 + 2nbd}$.

The accelerative force of the balance spring on the circumference of the balance at the point R is $+\frac{f}{a} \times \overline{d-x}$

The accelerative force of the auxiliary spring u, at the tension or distance from quiescence $Q\,d = a$ being nf, the force of the same spring at the tension or distance $QR = 2\,d - x$, is - - - - - $+\frac{nf}{a} \times \overline{2\,d-x}$

The force of the auxiliary spring v, at the tension $N\,e = a$ being $n\,f$, at the tension N R, the force of this spring acting by retardation will be - - - - $-\frac{nf}{a} \times x$.

Sum of the forces acting on the circumference of the balance, when it has described the arc N R = - - $\frac{f}{a} \times \overline{d-x+2\,d\,n-2\,n\,x}$.

Let u be the space through which a body falls freely from rest by the acceleration of gravity, to acquire the velocity of the circumference at R; the principles of acceleration give this equation; $\dot{u} = \frac{f}{a} \times \overline{d\,\dot{x} - x\,\dot{x} + 2\,d\,n\,\dot{x} - 2\,n\,x\,\dot{x}}$; and taking the fluents so that when $x = o$, u may be $= \frac{f}{2a} \times \overline{b^2 - d^2 + n\,b^2 - 3\,n\,d^2 + 2\,n\,b\,d}$; $u = \frac{f}{2a} \times \overline{b^2 - d^2 + n\,b^2 - 3\,n\,d^2 + 2\,n\,b\,d + 2\,\overline{d + 4\,n\,d} \times x - \overline{1+2\,n} \times x^2}$; if t is put to represent the time of describing the arc N R, $\dot{t} = \sqrt{\frac{a}{2\,l\,f}} \times \frac{\dot{x}}{\sqrt{b^2 - d^2 + n\,b^2 - 3\,n\,d^2 + 2\,n\,b\,d + \overline{2\,d + 4\,n\,d} \times x - \overline{1+2\,n} \times x^2}}$, and taking the fluents so that when $x = o$, $t = o$, and making $x = d$, the time of describing the arc NO $= \sqrt{\frac{a}{2\,l\,f \times \overline{1+2\,n}}} \times$ a circular arc of which the sine $= \sqrt{\frac{d^2 \times \overline{1+2\,n}}{b^2 + n \times \overline{b+d^2} - 2\,n\,d^2}}$, or because

$b + d = c$, $t = \sqrt{\frac{a}{2lf \times 1 + 2n}}$ × a circular arc of which the sine $= \sqrt{\frac{d^2 \times 1 + 2n}{b^2 + nc^2 - 2nd^2}}$.

The result is, that when the points of quiescence of the auxiliary springs are situated in the latter semiarcs of the respective vibrations, the time in which the balance describes the semiarc B O will be $= \sqrt{\frac{2a}{lf \times n + 1}}$ × a circular arc of which the sine is $\sqrt{\frac{b-d \times n+1}{2b+2nc}} + \sqrt{\frac{a}{2lf \times 1+2n}}$ × a circular arc of which the sine is $\sqrt{\frac{d^2 \times 1+2n}{b^2+nc^2-2nd^2}}$.

The balance of Mr. MUDGE's time-keeper describes the semiarc B O, by the joint action of two springs, *i. e.* the balance* spring, and an auxiliary spring; each spring is wound through the same arc B O, and comes to the same point of quiescence O (fig. 6.); consequently the action of the two springs is the same with that of a single spring of equal strength with both. In this case, the time of a semivibration through the arc B O, will be obtained from a former solution; for referring to page 126, and making O D $= a$, and the force of the balance spring and auxiliary spring at the distance from quiescence O D, $=$ $f + nf =$ F; the time of a semivibration is

$$= \sqrt{\frac{ap^2}{8lf \times n+1}} = \sqrt{\frac{ap^2}{8lF}}.$$

But if the points of quiescence of the balance and auxiliary springs instead of coinciding, according to the principle of Mr. MUDGE's construction, should deviate from this adjustment by a small arc O Q $=$ O N (fig. 4 and 5.); to what extent the

* A double spiral spring is applied in the balance of Mr. MUDGE's time-keeper, but as these two springs act as one spring, they are here considered as such.

daily rate of the time-keeper may be affected by this alteration in the position of the quiescent points, remains unknown, unless it be investigated by assuming the deviation of the points of quiescence, as one of the conditions on which the time of vibration depends. This condition is included in the preceding investigations, which may be now applied to the solution of some cases, which are suggested by considering the construction of Mr. MUDGE's time-keeper.

Any minute or particular description of this ingenious invention would be foreign to the subject of theoretic investigation; an outline only of the construction on which the action of the several springs depends will be necessary, to render the application of the preceding theorems sufficiently intelligible.

ONEBQ (Tab. XV. fig. 8.) is the circumference of the balance, vibrating by the action of a spiral spring on an axis C A D H, passing through the centre C; the axis is discontinued from A to D to make room for the other parts of the work. C A and D H are connected by means of a branch or crank A X Y D, which is fixed to the axis C A D H, and always vibrates with the balance on the said axis.*

L M, Z W, are two rods affixed to the crank at the points L and Z parallel to X Y; which rods also vibrate with the balance. *c, d, e, f, g, r, s,* are fixed parts of the machine. T R is an axis in the same right line with C A D H carrying an arm G O at right angles to it† (or nearly so), and a small auxiliary spring *u,* which is wound up whenever the arm G O is turned round

* The additional weight affixed to the balance at *t* counterpoises the weight of the crank or branch A X Y D, so as to bring the centre of gravity of the whole into the axis of motion.

† In the machine G O and I O are not exactly at right angles to T R and F S; but are so represented in the figure, in order to make the different positions of the arms G O and I O the more distinct.

the axis T R in the direction of the arc O *b*; *p* is a curved pallet fixed to the axis T R, which receives the tooth of the balance wheel near the axis; the tooth proceeding along the curved surface by the force of the main spring, turns the axis and the annexed arm G O in the direction of the arc O *b*, and at the same time winds up the auxiliary spring *u*. A small projection at the extremity of the curved surface of the pallet *p* prevents further progress of the tooth, when the arm O G has been turned through an arc O *b** of about 27°; consequently the spring *u* has then been wound through the same arc or angle O G *b* = 27°.

F S is another axis in the same right line with C A D H, exactly similar to that which has been described. This axis F S carries with it the arm I O; the auxiliary spring *v* is annexed to this axis, and is wound up when the axis is turned in the direction of the arc O *k*. *q* is a pallet similar to the former pallet *p*, and is placed so as to receive the tooth of the balance wheel, which by its action on the pallet winds up the spring *v*, and carries the arm O I through an angle O I *k*, = 27°, further motion being prevented by a small projection at the extremity of the pallet *q*, similar to that which has been already mentioned. *l m* represents the balance wheel, the upper tooth of which acts on the pallet *p*, and the lower tooth on the pallet *q*, alternately winding up the auxiliary springs *u* and *v*, in the manner described in the subsequent page: the axis of the balance wheel *n o* is parallel to the line C O or G O.

The several arcs expressed on the circumference of the balance, *i. e.* O Q, O *b*, O N, O *k*, are equal to the respective arcs denoted by the same letters in the circumference of the circles described by the extremities of the arms G O and I O.

* *Vide infra* the note in page 150.

Suppose that when the balance is quiescent, the main spring being unwound, the branch or crank A X Y D is in the position represented in fig. 8, A X being parallel to C O; if the quiescent points of the auxiliary springs coincide with that of the balance spring, the arm G O will just touch the rod L M; and in like manner the arm I O will just touch the rod W Z; the two arms G O and I O, in this position, are parallel to the line C O. This position of the balance and auxiliary springs remains as long as the main spring of the machine continues unwound; but whenever the action of the main spring sets the balance wheel in motion, a tooth thereof meeting with one or other of the pallets *p* or *q*, will wind up one of the auxiliary springs; suppose it should be the auxiliary spring *u*: the arm G O being carried into the position G *h*, by the force of the balance wheel acting on the pallet *p*, remains in that position as long as the tooth of the balance wheel continues locked by the projection at the extremity of the pallet *p*: and the balance itself not being at all affected by the motion of the arm G O, nor by the winding up of the spring *u*, remains in its quiescent position; consequently no vibration can take place except by the assistance of some external force to set the machine in motion. Suppose an impulse to be given to the balance sufficient to carry it through the semiarc O B, which is about* 135°, according to Mr. MUDGE's construction.

The balance during this motion carries with it the crank A X Y D, and the affixed rods L M, Z W. When the balance has described an angle of about* 27° = to the angle O C *h* or O G *h*, the rod L M meets with the arm G *h*, and by turning the axis T R, and the pallet *p*, in the direction of the arc O *h*, releases the tooth of the balance wheel from the pro-

* *Vide infra* the note in page 150.

jection at the extremity of the pallet *p*; the balance wheel immediately revolves, and the lower tooth meeting with the pallet *q* winds up the auxiliary spring *v*, and carries the arm I O with a circular motion through the angle O I *k* about 27°; in which position the arm I O remains as long as the tooth of the balance wheel is locked by the pallet *q*. While the spring *v* is winding up through the arc O *k*, the balance describes the remaining part of the semiarc *b* B, and during this motion the rod L M carries round the arm G *b*, causing it to describe an angle *b* C B, or *b* G B*, which is measured by the arc *b* B = †108°: when the balance has arrived at the extremity of the semiarc O B = 135°, the auxiliary spring *u* will have been wound up through the same angle = 135°, *i. e.* 27°, by the force of the main spring acting on the pallet *p*, and 108° by the balance itself carrying along with it the arm G O or G *b*, while it describes the arc *b* B. The balance therefore returns through the arc B O by the joint action of the balance spring, and the auxiliary spring *u*; the acceleration of both springs ceasing the instant the balance arrives at the quiescent point O; when the balance has proceeded in its vibration about 27° beyond the point O to the position C *k*, the rod Z W meets with the arm I *k*, and by carrying it forward releases the tooth

* The angle *b* G B is not expressed in the figure for want of room, but is easily imagined, being precisely equal to the angle *b* C B represented on the balance.

† This magnitude of the arc *b* B has been inferred from the following circumstances communicated by Mr. MUDGE. 1st. "The whole arc of vibration is about ¾ of "a circle, or 270°, consequently the semiarc of vibration is 135°. 2dly. The ac- "tion of the balance by carrying round the arm O G from *b* to B winds up the auxi- "liary spring through an angle about four times greater than the angle O C *b* through "which it is wound up by the action of the balance wheel on the pallet." Wherefore if O B, or 135°, is divided into five parts, one of them will be O *b* = 27°, and the other four parts, or *b* B = 108°.

of the balance wheel from the pallet *q*; the balance wheel accordingly revolves, and the upper tooth meeting with the pallet *p*, winds up the auxiliary spring *u* as before. The balance with the crank proceeding to describe the remaining semiarc *k* E, winds up the spring *v* through the further angle *k* C E = 108°; the balance returns through the semiarc E O, by the joint action of the balance spring and the auxiliary spring *v*, both of which cease to accelerate the balance the instant it has arrived at O.

It is remarkable, according to this construction, that no force or impulse whatever is communicated to the balance from the main spring, and yet the vibrations are continued of their due length: on further consideration it appears that the maintaining power of the machine, instead of communicating any force or impulse, acts by removing a part of the force which retards the balance while it is describing the latter semiarc of each vibration.

In the preceding account it has been shewn, that the balance describes the semiarc from B to O by the joint action of the two springs; now for a moment let it be supposed that the balance vibrated through the entire arc B O E (fig. 7 and 8.) by the joint action of the two springs, in the same manner as if one balance spring only was applied of the same strength with both; in this case, the balance commencing its vibration at the extremity of the arc B, after having passed the semiarc B O with an accelerated motion, would describe an equal arc O E on the other side of O, by retarded motion, provided it was not obstructed by friction or other irregular resistances; but such resistances taking place will cause the latter semiarc, which is described by retarded motion, to fall short of the arc O E by some small difference E S. There are two modes by which this latter semiarc may be restored to its due length O E; either by communicating an impulse to the balance from the

main spring, or by removing a part of the force which retards the ascent of the balance while it describes the latter semiarc O E. Mr. MUDGE has discovered and applied to his time-keeper the latter mode of supplying the power which is required to continue the balance in motion. During the progress of the balance through the semiarc B O, it is accelerated by the joint action of the balance spring and auxiliary spring *u*; but while it describes the latter semiarc O E (fig. 7 and 8.), it is retarded by the joint actions of the balance spring and auxiliary spring, only while it describes a part of the semiarc from *k* to E, the retardation of the auxiliary spring being removed while it describes the first 27° of this semiarc from O to *k*.

It is evident, according to Mr. MUDGE's construction, that the diminution of retardation, which is equivalent to the supply of power to the balance, must always be of the same magnitude, so far as regards the influence of the main spring, provided it has sufficient force to wind up the auxiliary springs through the constant angle O G *b* = O C *k* (fig. 8.); and the effects of heat and cold on the auxiliary springs are necessarily included in the compensation which is applied for heat and cold to the balance spring. The maintaining power therefore, by which the motion of the balance is continued, must be always uniformly the same; this is an object usually held to be of material consequence in the construction of watches, and though often attempted by ingenious persons, has probably been accomplished in its full extent for the first time by Mr. MUDGE.

This construction possesses the further advantage of having the balance perfectly detached from the wheel work of the machine; the only communication* between the balance and the

* The exact times in which the balance describes any portions of the arc of vibration may be readily obtained by having recourse to the theorem investigated in page

balance wheel is that which subsists while the pallet is disengaged from the tooth; an instant of time in a practical sense almost evanescent: it should also be remarked, that the pressure of the tooth against the projection of the pallet is diminished before the tooth is released, by the counteraction of the other pallet on the opposite tooth of the balance wheel; which action takes place just before the tooth of the balance wheel first mentioned is released from the pallet: by this diminution of pressure, the tooth is the more easily detached from the projection of the pallet. These circumstances concur in giving to the machine facility and lightness of motion.

The preceding investigations are in the next place to be ap-

126. If we can ascertain the arc described by the balance while the tooth of the balance wheel is released from the projection of the pallet, the portion of time in which the balance is connected with the wheel-work of the machine will be known. By an experiment made on a very exact model of Mr. MUDGE's construction, it appeared that the balance described an arc of about 8°, while the tooth was released from the pallet. And since the balance describes 108° of its semivibration before the pallet begins to be moved, it will have described 116° before the tooth is released; we are therefore to find the times in which the balance describes severally the two arcs 108° and 116°: the difference of these times will be the time in which the balance wheel is released from the pallet. By the theorem referred to

	Parts of a second.
The time in which the balance describes an arc of 116° is -	0.09101
Time of describing an arc of 108° is - - -	0.08718
The difference, or time during which the balance is connected with the other parts of the machine, - - - -	0.00383

which is about $\frac{1}{260}$ part of a second of mean time, the effects of friction not being here considered.

If therefore the time of a semivibration is supposed to be divided into 100 equal parts, or physical instants, during the first 91 of them the balance will describe 108° from the extremity of the arc of vibration, to the contact of the arm connected with the pallet. During the 4 succeeding instants the pallet will be released, and during the 5 instants following, the balance will describe the remaining arc of the semivibration. Thus it appears, that the balance moves perfectly free and unconnected with the wheel-work of the machine during 96 parts in 100 of the time of each vibration.

plied to ascertain what alteration of the daily rate is occasioned in consequence of any deviation from coincidence of the points of quiescence of the balance spring and auxiliary springs, (fig. 8, and fig. 4 and 5.) that may have taken place either through a casual derangement of their position, or from a purposed adjustment. This inquiry offers three cases, which are to be separately considered; the first is, when the points of quiescence of the auxiliary springs coincide with the point of quiescence of the balance spring. 2dly. When the point of quiescence Q of the auxiliary spring *u* is situated in the first semiarc of the vibration, or between B and O (fig. 4 and 8.). 3dly. When Q is situated in the latter semiarc of vibration between E and O (fig. 5.); the like cotemporary position is to be understood in respect of the other auxiliary spring.

The consideration of these cases requires that the accelerative* forces of the balance spring and auxiliary springs, when at a given tension, should be known. This point will not be difficult to ascertain, if the proportion of the spring's forces at the same tension is given. By information received from Mr. MUDGE, it appears that the force of each auxiliary spring is about $\frac{1}{20}$ part of the force of the balance spring. Assuming this proportion, let the points of quiescence of the auxiliary springs be supposed to coincide with the point of quiescence of the balance spring, and let the radius of the balance be taken at one inch; the watch being adjusted to mean time, when the balance makes five vibrations in a second, if the force of gravity is $= 1$, the force which accelerates the circumference at an

* The accelerative force being always proportional to the absolute forces of impulse (as measured or counterpoised by a weight) divided by the mass moved equivalent to the resistance of inertia, the latter quantity remaining the same in the case of a balance's vibration, the accelerative forces will be in the same ratio with the forces of impulse.

angular distance of 90° from the quiescent point will be = 1.00408926 (p. 129): this force, in the present instance, is compounded of the force of the balance spring, and that of the auxiliary spring, which are assumed to be in the proportion of 20 to 1; consequently the force of the balance spring to accelerate the circumference at the tension 90°, or $f =$ 0.9562754
and the force of the auxiliary spring at the same tension, or $\frac{1}{20}$ of $f =$ - - - .0478138

Joint force of both springs to accelerate the circumference at the tension, 90° or $f + \frac{1}{20} f =$ 1.0040892

With* this force the balance vibrates five times in one se-

* From the investigation in page 128 it appears, that if F is the accelerative force on the circumference of the balance at the angular distance from quiescence $c°$, $p =$ 3.14159, &c. $r =$ the radius of the balance expressed in inches, $l =$ 193 inches; the time of a semivibration will be $= \sqrt{\frac{p^3 r c°}{8 l F \times 180°}}$.

In the present case $c° = 90°$, $r =$ 1 inch $F = f + \frac{1}{20} f =$ 1.0040892; wherefore the time of a semivibration $= \sqrt{\frac{p^3 r c°}{8 l F \times 180°}} = \frac{1}{10}$ part of a second precisely.

If the balance should vibrate by the force of the auxiliary springs only, the force of acceleration on the circumference at the distance 90° from quiescence is $\frac{1}{20} f =$ 0.0478138; wherefore $\frac{1}{20} f$ being substituted for F in the quantity $\sqrt{\frac{p^3 r c°}{8 l F \times 180°}}$ the other values remaining the same as in the former case, the time of a semivibration will now be $\sqrt{\frac{p^3 r c°}{8 l \times \frac{1}{20} f \times 180°}} =$ pts. of a sec. .45825; and the time shewn by the watch in any portion of mean time t will $= \frac{t}{4.5825} = t \times .21822$. Thus if t should be taken = to one minute, or 60 seconds of time, the time shewn by the watch in 60 seconds will be $= 60 \times .21822 =$ 13 seconds nearly.

This would be the result if the forces of the balance and auxiliary springs were precisely in the proportion of 20 to 1. Mr. Mudge mentioned this proportion by esti-

cond when adjusted to mean time; the daily rate will therefore in this case be = 0.

Now let Q (fig. 4 and 8.), or the point of quiescence of the auxiliary spring deviate from O, the point of quiescence of the balance spring, by an arc O Q; suppose this arc O Q to be = 1°; and let the point Q be situated in the first semiarc of vibration between O and B. The time of describing the semiarc B O will be ascertained on these conditions, by referring to the investigation (page 140), and making the following substitutions:

$a = 1.5707963$ = an arc of 90° to radius = 1 *

$b = 2.3561945$ = an arc of 135°

$c = 2.3387412$ = an arc of 134°

$b - c = d = 0.0174533$ = an arc of 1°

$l = 193$

$f = 0.9562754$

$n = \frac{1}{20}$.

mation only, not having any memorandum of experiments made to ascertain the exact proportion.

If therefore the actual rate of the watch should be observed when the balance vibrates by the action of the auxiliary springs only, it is probable that the time shewn by the watch in 60 seconds of mean time might differ somewhat from that which has been here stated.

Since these notes were written, I have been favoured by his Excellency Count BRUHL with an account of an observation made on the rate of Mr. MUDGE'S first time-keeper, when the balance vibrated by the action of the auxiliary springs only, the balance spring being removed. According to this observation, the watch shewed twelve minutes by the motion of the hands in one hour of mean time, which corresponds to an interval of 12 seconds of time, shewn by the watch in 60 seconds, or one minute of mean time. According to the calculation, 13 seconds of time are shewn by the watch in one minute. A nearer agreement between the theory and matter of fact could scarcely be expected in the circumstances of the experiment.

* In all the following calculations the radius is also = 1.

Then, $\sqrt{\frac{2a}{lf \times n+1}}$ × into a circular arc, of which the sine is

$\sqrt{\frac{c \times n+1}{2b+2nc}}$ = - - - parts of a second. 0.0995070

$\sqrt{\frac{a}{2lf}}$ × into a circular arc, of which the sine

is $\sqrt{\frac{d}{b^2+nc^2}}$ = - - - 0.00047174

Time of a semivibration in the arc B O = - .10002244

The time shewn by the watch in $24^h = \frac{24^\circ}{1.0002244} = 23^h\ 59'\ 40''.60$, giving a daily rate of 19″.40 slow.

This variation of the daily rate is not to be considered as affecting the regularity of the watch, as it is either compensated by adjustments when the watch is regulated to mean time, or taken as the established rate. A more material point is next to be determined; admitting the deviation of O and Q (fig. 4. and 8.) to be O Q = 1°, the same as in the former case; suppose the semiarc of vibration to be diminished from 135° to 125°. If the points of quiescence O and Q were coincident, this diminution of the arc of vibration would cause no alteration (page 128) in the time of a semivibration, because the forces of acceleration of both springs would be as the angular distances from the same quiescent point O; but since these points are separated by an arc of 1°, a diminution of 10° in the semiarc of vibration, will cause a change in the daily rate, which will be obtained from the general theorem (page 140) by making the following substitutions:

$a = 1.5707963$ = an arc of 90°

$b = 2.1816616$ = an arc of 125°

$c = 2.1642083$ = an arc of 124°

$b - c = d = 0.0174533$ = an arc of 1°.

$l = 193$

$f = 0.9562754$

$n = \frac{1}{20}$.

$\sqrt{\frac{2a}{lf \times n+1}}$ × into a circular arc, of which the sine is

$\sqrt{\frac{c \times n+1}{2b+2nc}} =$ - - - parts of a second. 0.09951472

$\sqrt{\frac{a}{2lf}}$ × a circular arc, of which the sine is

$\frac{d}{\sqrt{b^2+nc^2}} =$ - - - - 0.00050949

The time of a semivibration - .10002421

Time shewn by the watch in $24^h = \frac{24^h}{1.0002421} = 23^h\ 59'\ 39''.08$

giving a daily rate of - - - 20″.92 slow.

Daily rate, when the semiarc of vibration was 135° 19″.40 slow.

Retardation of the daily rate in consequence of the diminution of the semiarc of vibration from

135° to 125° - - - - 1″.52.

In these examples, the point of quiescence of the auxiliary spring Q is situated in the first semiarc of vibration between B and O; and in consequence of this position, the daily rate of the time-keeper is retarded by a separation of the points of quiescence, while the semiarc of vibration remains the same; *i. e.* 135°; secondly, the separation of the points of quiescence remaining unaltered, a diminution of the arc of vibration causes a further retardation of the rate. Opposite effects on the daily rate take place when the point of quiescence Q is situated in the latter semiarc of vibration, (fig. 5.) between O and E. The arc O Q remaining = 1° as before, this case produces an acceleration instead of a retardation of the rate.

Suppose the semiarc of vibration B O to be 135°
Separation of the points of quiescence = O Q 1°

Arc B Q in fig. 5, or B N in fig. 8. - 136°

The time of describing the semiarc B O will be determined by referring to the theorem (page 146).

making $a = 1.5707963$ = an arc of 90°
$b = 2.3561945$ = an arc of 135°
$c = 2.3736478$ = an arc of 136°
$d = 0.0174533$ = an arc of 1°
$l = 193.$
$f = 0.9562754.$
$n = \frac{1}{20}.$

The time of describing the semiarc B O = $\sqrt{\frac{2a}{lf \times n+1}}$

× a circular arc of which the sine is $\sqrt{\frac{b-d \times n+1}{2b+2nc}}$ = 0.09950617 Parts of a second.

$\sqrt{\frac{a}{2lf \times 1+2n}}$ × a circular arc of which the sine

is $\sqrt{\frac{d^2 \times 1+2n}{b^2+nc^2-2nd^2}}$ - - = 0.00047141

Time of a semivibration in the arc B O = 0.0997758

Time shewn by the watch in $24^h = \frac{24^h}{.9997758} = 24^h\ 0'\ 19''.38$,

giving a daily rate of 19.″38 fast.

Every thing else remaining, let the semiarc of vibration be diminished from 135° to 125°, and make

$b = 2.1816616$ = an arc of 125°
$c = 2.1991149$ = an arc of 126°

The time of describing B O will now be $\sqrt{\frac{2a}{lf \times n+1}}$ × a

circular arc of which the sine is $\sqrt{\frac{b-d \times n+1}{2b+2nc}}$ = 0.09946662 Parts of a second.

$\sqrt{\frac{a}{2lf \times 1+2n}}$ × a circular arc of which the sine

is $\sqrt{\frac{d^2 \times 1+2n}{b^2+nc^2-2nd^2}}$ - - = .00050912

Time of a semivibration in the arc B O = .09997574

Time shewn by the watch in $24^h = \frac{24^h}{.9997574} = 24^h\ 0'\ 20''.91$,

giving a daily rate of - - 20″.91 fast.

Daily rate when the semiarc of vibration was

135° - - - 19″.38 fast.

Acceleration of the rate in consequence of the

diminution of the semiarc of vibration from 135°

to 125° = - - - - 1″.53

The theorem from which this latter result has been calculated is founded on a supposition, that the arc B N (fig. 5.) is described by the accelerative forces of the balance spring and the auxiliary spring *u*, and that the arc N O is described by the accelerative forces of the two springs just mentioned, combined with the retarding force of the other auxiliary spring *v*, of which the point of quiescence is situated at N (fig. 5.). It may possibly be thought, that this supposed action of the auxiliary spring which retards the balance while it describes the arc from N to O, cannot take place, because by the peculiar construction of Mr. MUDGE's invention, when the balance vibrates from B towards E, the retarding force of the auxiliary spring is removed from acting on the balance while it describes the arc N *k* = 27° (fig. 5.), including the said arc NO; but it is to be considered, that this removal of the retarding force from

acting on the balance while it describes the arc from N to *k*, is merely a mechanical expedient for supplying the power which is lost by friction, and as it is thus wholly employed and counteracted, it appears requisite, in making calculations of the times in which the balance vibrates, that the entire forces of the springs are to be taken into the calculation in the same manner as if friction did not exist, and no mechanical contrivance was necessary for compensating the loss of motion in consequence of it. But since, in point of fact, no retarding force acts on the balance while it describes the arc N O, according to the conditions under consideration, it may be satisfactory to calculate the time of a semivibration in the arc B O on this ground also, that is, on a supposition that the entire semiarc B O is described by the joint accelerative forces of the balance spring, and the auxiliary spring *u* only; it will appear that this slight variation of the conditions does not at all affect the conclusions deduced from the preceding calculations, and very little alters the results themselves.

The time of describing the semiarc BO, on these conditions, will be determined by referring to the theorem (page 141), and making the following notations.

$a = 1.5707963$ = an arc of 90° to radius = 1
$b = 2.3561945$ = an arc of 135°
$c = 2.3736478$ = an arc of 136°
$d = 0.0174533$ = an arc of 1°.
$l = 193$
$f = 0.9562754$
$n = \frac{1}{20}$.

The time of a semivibration is $= \sqrt{\frac{2a}{lf \times n+1}} \times$ into a cir-

cular arc, of which the sine $= \sqrt{\frac{b \times n+1}{2b+2nc}} =$ pts. of a second. .0999775^2.

Time shewn by the watch in $24^h = \frac{24}{.9997752} = 24^h\ 0'\ 19''.42$, giving a daily rate of 19″.42 fast.

Every thing else remaining, let the semiarc of vibration be diminished from 135° to 125°; and make

$b = 2.1816616$ = an arc of 125° to radius 1.

$c = 2.1991149$ = an arc of 126°.

The time of describing the semiarc B O will now be $=$

$\frac{2a}{lf \times n+1}$ × a circular arc, of which the sine $= \sqrt{\frac{b \times n+1}{2b+2nc}}$

$=$ 0.0999757o parts of a second.

Time shewn by the watch in $24^h = \frac{24^h}{.9997570} = 24^h\ 0'\ 20''.96$,

giving a daily rate of - - - 20″.96 fast.

daily rate, when the semiarc of vibration was 135° = 19″.42 fast.

Acceleration of daily rate in consequence of the diminution of the semiarc of vibration from 135° to 125° - - - - 1″.54,

scarcely differing from the former determination in page 160.

By having recourse to the figure, we may distinctly perceive the three quiescent positions of the arms G O and I O, (fig. 8.) in respect to the rods L M, Z W, which correspond with the several conditions assumed for the calculation of the preceding examples. In the first place, the crank A X Y D, and the arms G O, I O, being in their quiescent position, it is evident from the preceding observations, that when the arms G O, I O are adjusted so as just to touch the rods L M, Z W, the points of quiescence of the auxiliary springs *u* and *v* coincide with the point of quiescence of the balance spring O, (fig. 6.) and in

this case, the balance making 5 vibrations in a second when adjusted to mean time, the daily rate is = 0 (p. 146).

Secondly, suppose the arms G O and I O to be so affixed to the axes T R, F S, (fig. 8 and 4.) that instead of just touching the rods L M and N W when quiescent, they are inclined* to that position at any angle O G Q = O I N: the situation of the pallets *p* and *q* not being altered: in this case the point of quiescence of the auxiliary spring *u*, will be separated from the point of quiescence of the balance spring by the angular distance OGQ = OCQ. In like manner the point of quiescence of the auxiliary spring *v* will deviate from the point of quiescence of the balance spring by the angular distance O I N = O C N. Suppose that the arc OQ = ON is = 1°: the point of quiescence Q of the auxiliary spring *u* is in the first semiarc of vibration, that is, between B and O, (fig. 4.) while the balance vibrates from B to E; and the point of quiescence of the auxiliary spring *v*, is in the first semiarc of vibration between E and O, while the balance vibrates from E to B; on these conditions, the semiarcs of vibration B O and OE being 135°, the daily rate of the time-keeper will be 19″.40 slower than mean time, (p. 157) and if the semiarcs BO, O E, should be diminished from 135° to 125°, the daily rate will be 20″.92 slow (p. 158); the retardation of the daily rate in consequence of the diminished semiarc of vibration being 1″.52.

To consider the remaining case; if the arms G O, I O, (fig. 8.) are adjusted so as to press equally by the force of the auxiliary springs against the rods L M, W Z, when quiescent, the equal and contrary pressures prevent any apparent effect

* The force of the main spring not being supposed to act on the balance wheel, or pallets *p* and *q*.

on the position of the balance or crank A X Y D; if the rod LM should be removed (by turning the balance in its plane), suppose that the arm GO rests in a position GN, at a distance beyond O, which is measured by the arc O N = 1°; in this position the point of quiescence of the auxiliary spring *u* will be situated in the latter semiarc of vibration at N, between E and O, and by a similar adjustment of the quiescent position of the arm IO, (fig. 5 and 8.) the point of quiescence of the auxiliary spring *v* will be situated at Q in the latter semiarc of the vibration, between O and B; in consequence of this position of the points of quiescence, the daily rate of the watch will be accelerated 19″.38, (p. 159) while the semiarc of vibration continues 135°, and when the semiarc of vibration is diminished to 125°, the daily rate will be further accelerated; the rate being 20″.91 fast, (page 160) or 1″.53 faster than when the semiarc of vibration was 135°.

From these several* results it may be concluded, that although the rate of going of Mr. MUDGE's time-keeper depends materially on the quiescent position of the arms G O, I O, (fig. 8.), that is, on the position of the points of quiescence of the auxiliary springs, yet while that position remains unaltered, whatever it may be, the regularity of the time-keeper will not be affected in consequence of the said position, provided the semiarc of vibration continues the same; but when this arc is

* It is scarcely necessary to observe, that although these results have been investigated from supposing the elastic forces of the spiral springs to be in the precise law of the tensions, or distances from quiescence; yet if the spring's forces should deviate somewhat from that law, the general conclusions deduced from the preceding calculations, respecting the acceleration or retardation of the rate arising from an alteration in the position of the points of quiescence, will still be true, although the degree in which these effects take place may not be exactly the same as when the spring's forces are in the precise law assumed in the investigations.

diminished, an acceleration or retardation of the daily rate will take place, according to the situation of the points of quiescence of the auxiliary springs referred to the semiarcs of vibration in which these springs respectively act. If the points of quiescence of the auxiliary springs should be situated in the first semiarcs of vibration, a diminution of these arcs will cause a retardation of the rate; but if the points of quiescence should be situated in the latter semiarcs of the respective vibrations, the daily rate will be accelerated.

By means of Mr. MUDGE's construction, we may apply the principles deduced from the preceding investigations to correct such alterations in the daily rate as may arise from a diminished or increased arc of vibration. For if it should be known, from any satisfactory mode of trial, that the properties* of the balance spring are such as cause the longer arcs of vibration to be described in less time than the shorter arcs; whenever the arc of vibration is diminished, the time-keeper will lose; and this error in the rate would be corrected by adjusting the points of quiescence of the auxiliary springs in the respective latter semiarcs of vibration at such a distance ON.

* Different opinions have been entertained respecting the times in which a balance, vibrating freely by the action of a spiral spring, describes the longer and shorter arcs of vibration. Mr. HARRISON says, "large arcs are naturally performed in less time than "small ones."—Notes taken at the Discovery of Mr. HARRISON's Time-keeper, p. vii. In this opinion he is followed by M. BERTHOUD; "J'ai appris par des experiences sûres, "que les grand arcs et les petits arcs d'un balancier ne sont pas isochrones, et qu'en "general, dans un balancier libre, les grands arcs sont plus prompts que les petits." Mr. LUDLAM, in his report addressed to the commissioners of the board of longitude, and intituled, a Short View of the Improvements made or attempted in Mr. HARRISON's Watch, has the following remark: "The principle on which Mr. HARRISON forms "the alteration of the third part (before described) is, that the longer vibrations of a "balance moved by the same spring are performed in less time. This is contrary to "the received opinion among philosophers and workmen."

These contradictory opinions may possibly have arisen from experiments, in which

= O Q (fig. 8 and 5.) from the point of quiescence of the balance spring, as corresponds with the error intended to be rectified.* In like manner, if the property of the balance spring should be such that a diminution of the arc of vibration causes an acceleration of the daily rate, this error will be corrected by placing the points of quiescence of the auxiliary springs in the first semiarcs of vibration, (fig. 4 and 8.) at their proper distances from the point of quiescence of the balance spring. It is, however, to be remarked, that if the balance spring should be of the latter kind here assumed, and the points of quiescence of the auxiliary springs, either by any casual derangement in their position, or by an adjustment of them for the purpose of experimental observation, should be placed in the latter semiarcs of vibration, the effect of this position would be an acceleration of the rate, whenever the semiarc of vibration is diminished: and this effect would be produced on a double account; first, from the assumed nature of the balance spring, which disposes it to describe the smaller arcs in less time

all the circumstances capable of influencing the times of vibration in longer or shorter arcs, were either not noticed, or omitted to be properly allowed for; this will seem the more probable if it be allowed, that a balance spring may be adjusted in various ways so that either the longer or shorter arcs shall be performed in the least time; not only by altering the thickness and strength of the spring in different parts, but, if we subscribe to the opinion of M. BERTHOUD, in a spring uniform in every respect throughout, by altering the length and number of turns. He infers, that a certain length and number of turns may be given to an uniform spiral spring which will make it perfectly isochronal. This latter principle, however, does not appear to have been verified by any satisfactory experiments. According to the inferences deduced from the preceding investigations, three spiral springs, which are not isochronal when acting singly, may be so united by properly adjusting their points of quiescence, that their combined action shall cause the balance to perform its vibrations in any two arcs of unequal lengths in the same time.

* The position of the points of quiescence of the auxiliary springs is here understood to be altered, by affixing the arms G O, I K, differently on the axes T R, F S; the quiescent position of the pallets being no ways changed.

than the larger arcs of vibration: and secondly, from the position of the points of quiescence of the auxiliary springs. But it is evident from the preceding considerations, that although the balance spring should not be isochronal, yet the regularity of the time-keeper will not be at all affected, however the points of quiescence of the auxiliary springs may be situated in respect of the point of quiescence of the balance spring, as long as the semiarc of vibration continues unchanged; and if the semiarc of vibration should be liable to increase or diminution, Mr. MUDGE's construction affords an effectual remedy against this cause of variation in the rate, since the arms projecting from the auxiliary springs may be so adjusted, as to place their points of quiescence either in the first or latter semiarcs of vibration, according as the balance spring, when acting singly, causes the shorter or longer vibrations to be described in the least time.

On revising the preceding pages a few observations have occurred, which may be here inserted.

Note to page 122, *line* 13.—The elastic force of the spiral spring when at a given tension to turn the balance, is here assumed to be the same, whether the balance is at rest or in motion, being in both cases equal to the weight by which the spring's force at the given tension would be counterpoised.

Note to page 131.—It is not necessary to add constant quantities to the fluents of the fluxions $\frac{-\dot{x}}{\sqrt{b^{n+1}-x^{n+1}}}$, $\frac{-\dot{y}}{\sqrt{c^{n+1}-y^{n+1}}}$; because when the entire fluents are taken, they are precisely in the same proportion, whether the constant quantities (or corrections as they are sometimes termed) are added or omitted.

Addition to the note in page 140.—If the points of quiescence are in the first semiarc of vibration, and $c = 0$, the point B will coincide with Q (fig. 4.), from which point the vibration will commence; in this case the expression for the time of a semivibration will become $t = \sqrt{\frac{a}{2lf}} \times$ an arc of which the sine is $\frac{d}{d}$, or an arc of $90° = \frac{p}{2}$, or $t = \sqrt{\frac{ap^2}{8lf}}$; which agrees entirely with the solution in page 126; for in this case the auxiliary spring not acting on the balance while it describes the arc Q O N, the balance will vibrate by the force of the balance spring only; of which the force at the distance a or $90°$ is $= f$, and consequently by the theorem investigated in page 126,

the time of a semivibration is $\sqrt{\frac{a\,p^2}{8\,l\,f}}$ the same as is deduced from the more general expression.

Corollary to the solution in page 146.—If the points of quiescence of the auxiliary springs are in the latter semiarcs of vibration, and the vibration commences from the point N (fig. 5.), in this case $d = b$, or $c = 2\,d$, and by the solution in page 146, the time of a semivibration becomes $\sqrt{\frac{a}{2\,l\,f \times 1 + 2\,n}}$ × an arc of which the sine is $\sqrt{\frac{d^2 \times 1 + 2\,n}{d^2 \times 1 + 2\,n}}$, or an arc of $90° = \frac{p}{2}$: wherefore the time of a semivibration $= \sqrt{\frac{a\,p^2}{8\,l\,f \times 1 + 2\,n}}$. We observe, therefore, that whether the points of quiescence of the auxiliary springs are situated in the first or latter semiarcs of vibration, if the semiarc of vibration should be = to the distance of the said points from the point of quiescence of the balance spring, the times of vibration will be the same whatever be the magnitude of that semiarc.

Note to page 164.—Supposing, as in the former examples, the points of quiescence of the auxiliary springs to be at the distance of 1° from the point of quiescence of the balance spring, the variations of rate from mean time, when the semiarcs of vibration are 135°, 125°, 60°, and 10° severally, will be as expressed underneath:

Points of quiescence in the first semiarcs of vibration.

Semiarcs of vibration.	Variation of the daily rate from mean time.
135°	— 19″.40
125°	— 20″.92
60°	— 44″.33
10°	— 4′.24″.24

Points of quiescence in the latter semiarcs of vibration.

135°	+ 19″.38
125°	+ 20″.91
60°	+ 43″.60
10°	+ 4′.23″.60

If auxiliary springs should be applied for the sole purpose of making the vibrations of the balance isochronal, it may probably be found convenient to adjust the points of quiescence of the auxiliary and balance springs at a greater distance than 1°; suppose the distance to be 10°. Let the arc of vibration be 450°, or $1\frac{1}{4}$ of a revolution, and suppose the balance to make four vibrations in a second; on these conditions two auxiliary springs, each of which is about $\frac{1}{40}$ part of the force of the balance spring, or perhaps a single auxiliary spring proportionally stronger, will, in most cases, be sufficient to compensate for the want of isochronism in the balance spring.

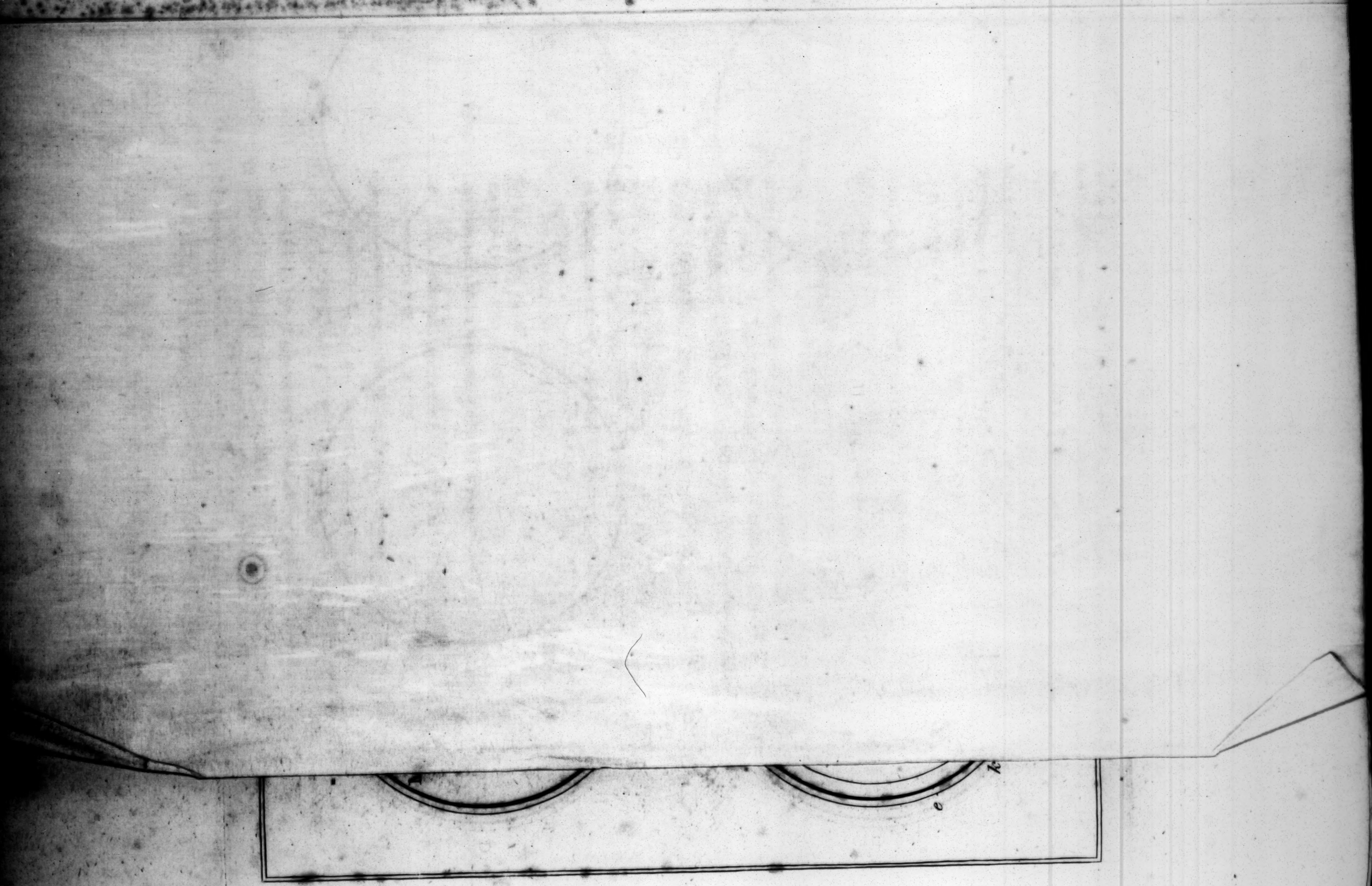

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Fig. 1.

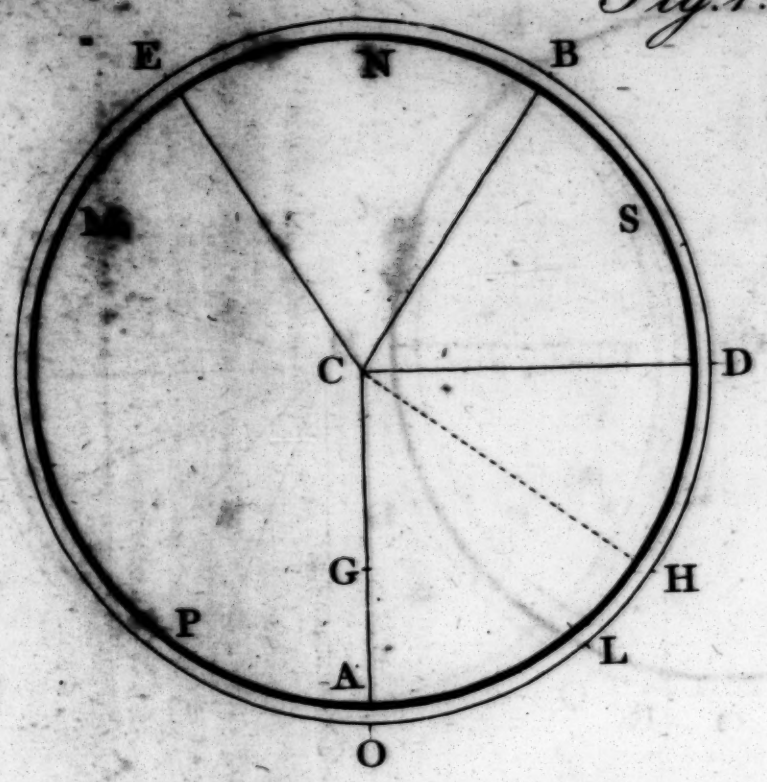

Fig. 2.

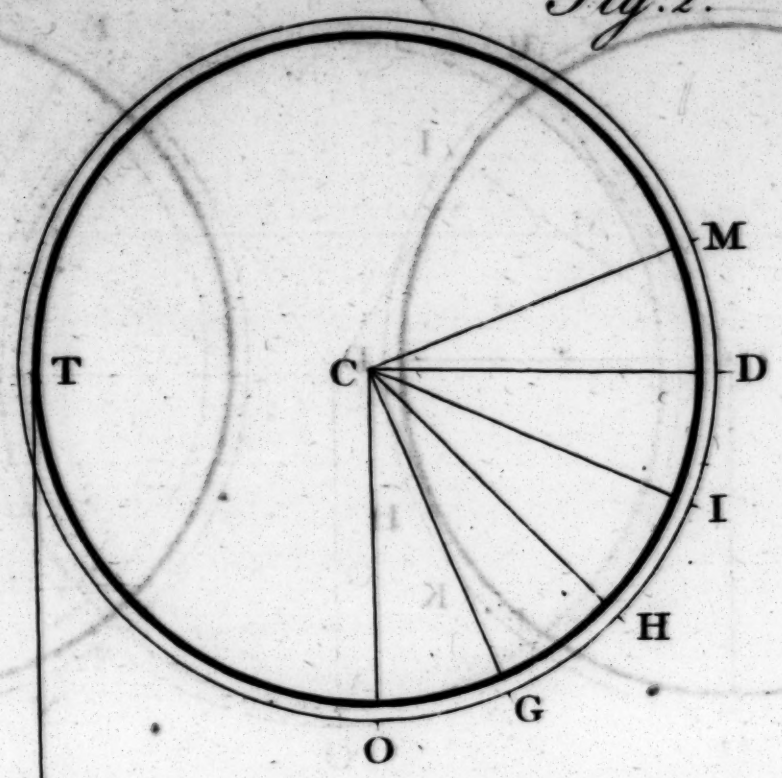

Fig. 5.

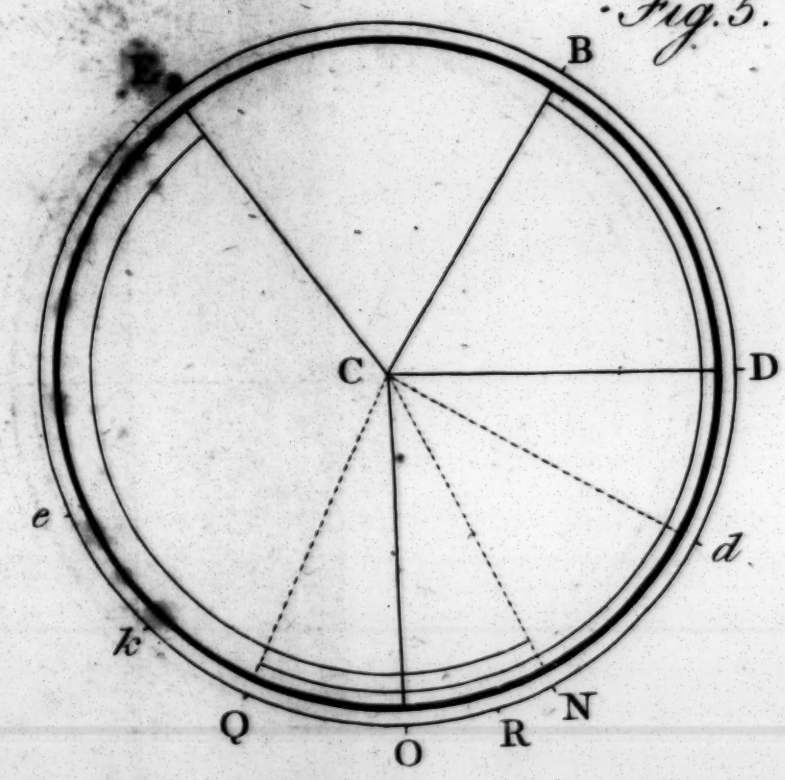

Fig. 6.

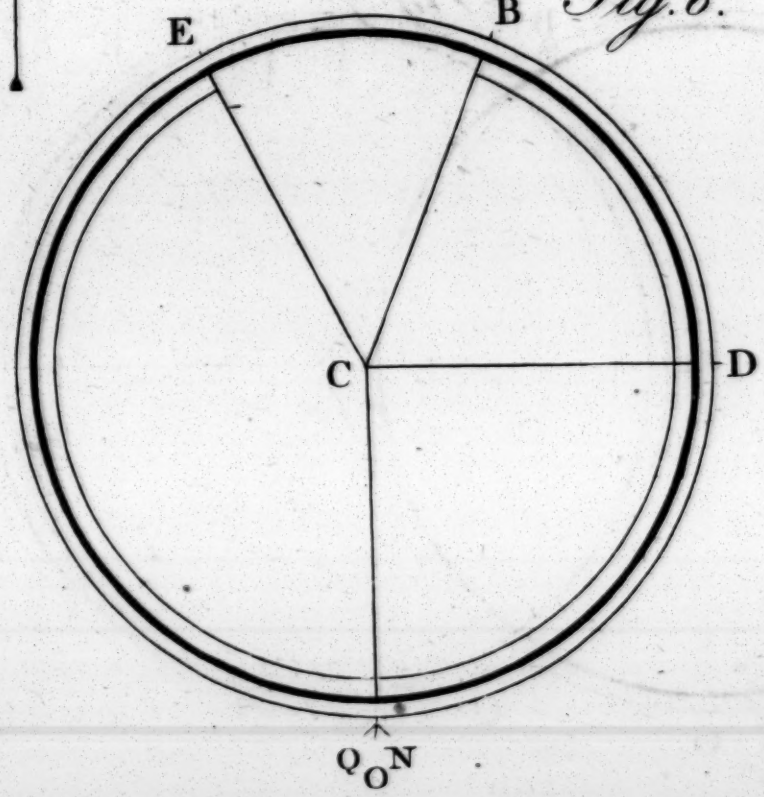

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Fig. 2.

Fig. 3.

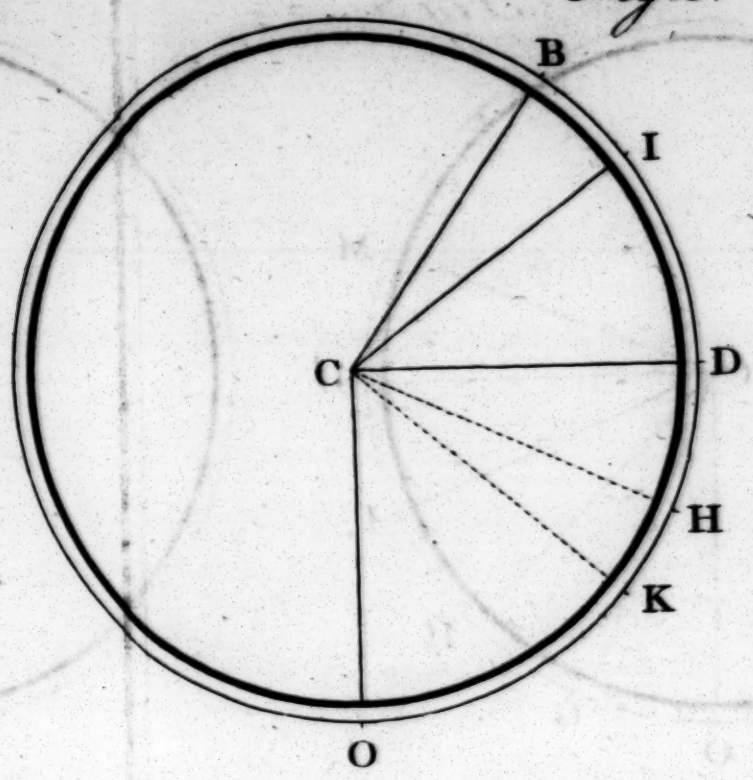


Fig. 4.

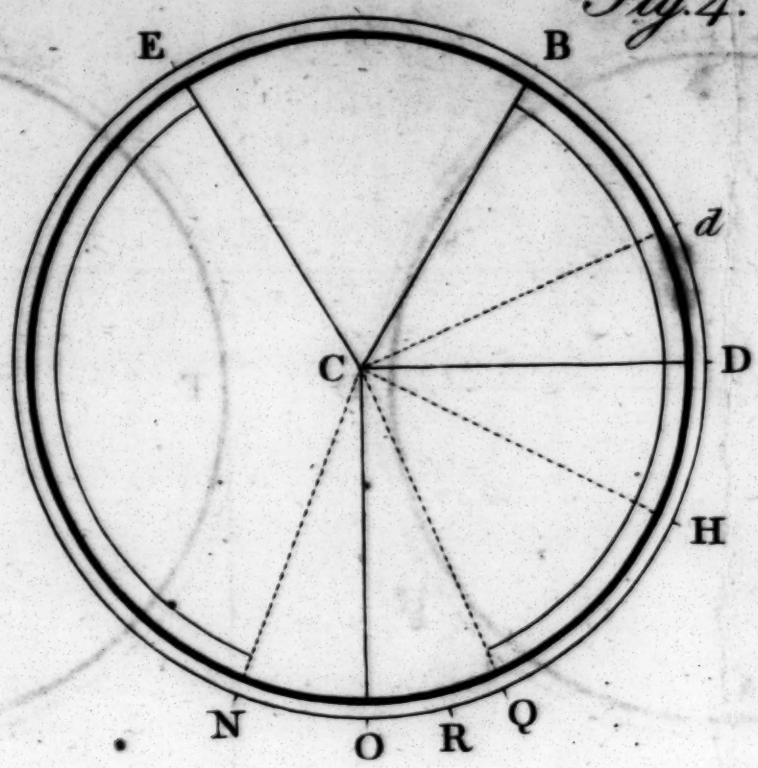


Fig. 6.

Fig. 7.

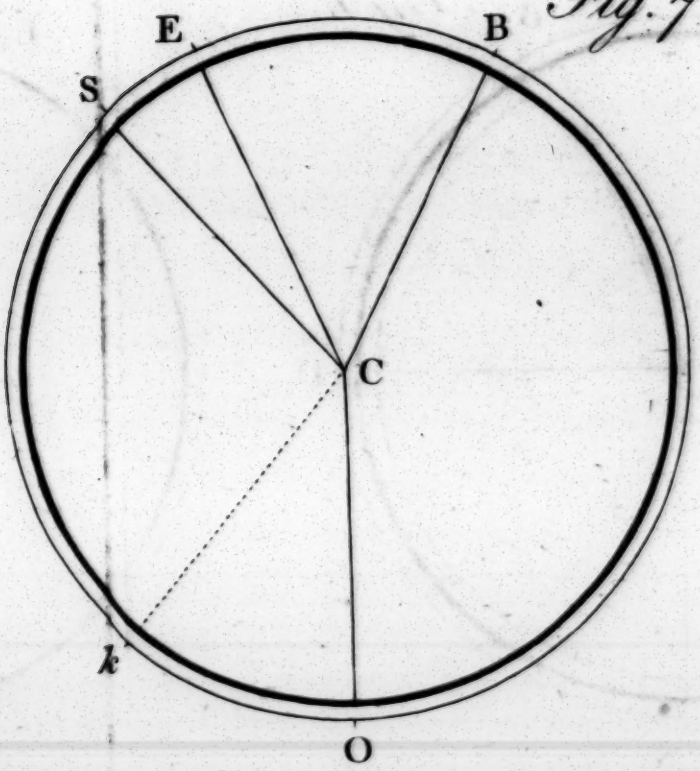
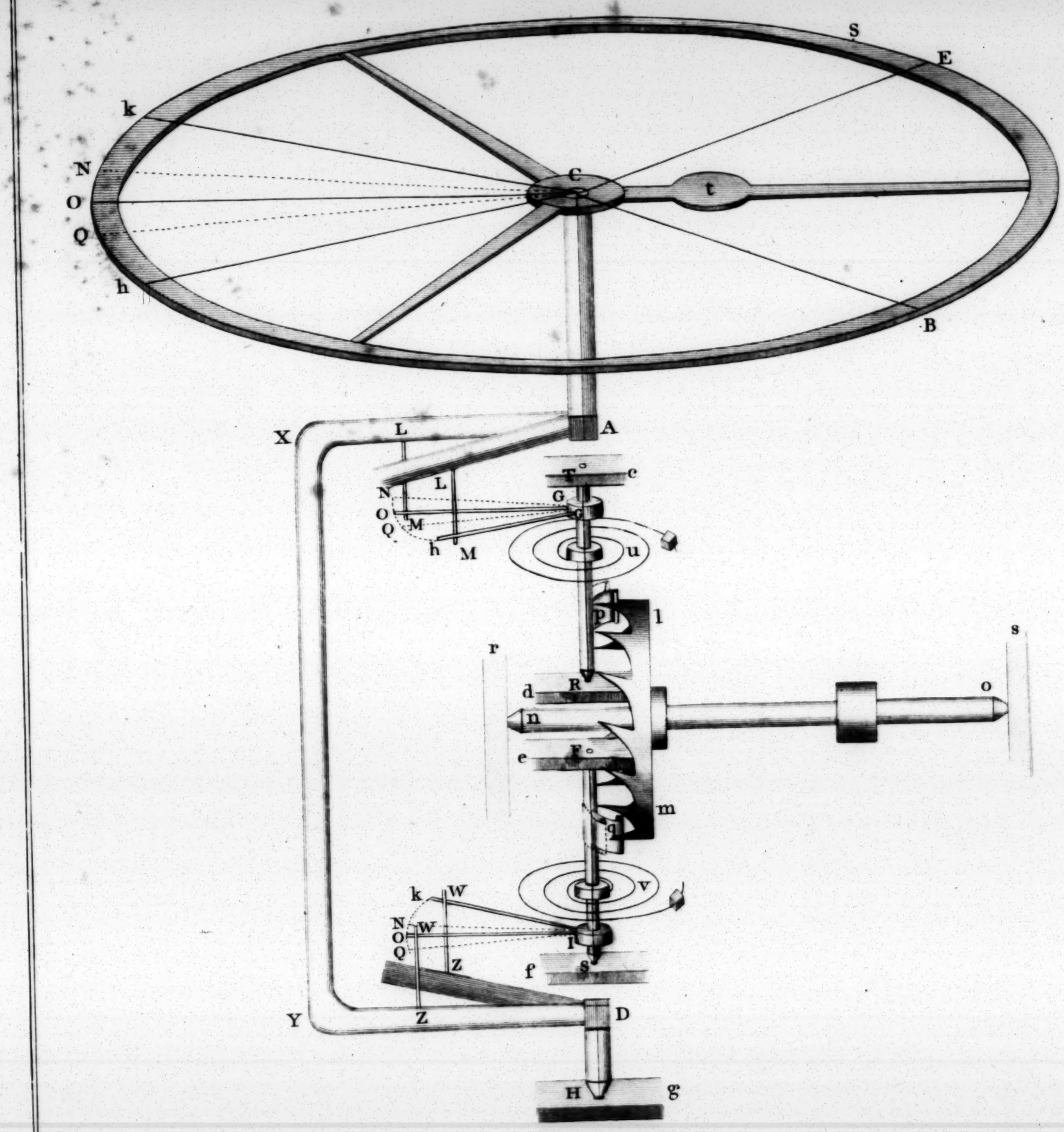


Fig. 8.



METEOROLOGICAL JOURNAL,

KEPT AT THE APARTMENTS

OF THE

ROYAL SOCIETY,

BY ORDER OF THE

PRESIDENT AND COUNCIL.

METEOROLOGICAL JOURNAL

for January, 1793.

1793	Time.		Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds.		Weather.
	H.	M.	o	o	Inches.		Inches.	Points.	Str.	
Jan. 1	8	o	35	50	29,86	72		SE	1	Cloudy.
	2	o	36	52	29,77	72		SSE	1	Cloudy.
2	8	o	35	49	29,77	77	0,127	NNE	1	Foggy.
	2	o	38	51	29,77	75		NW	1	Cloudy.
3	8	o	30	49	29,93	76				Foggy.
	2	o	31,5	52	29,92	75		W	1	Foggy.
4	8	o	31,5	48	29,62	75		E	2	Cloudy.
	2	o	34	49	29,73	73		E	2	Cloudy.
5	8	o	34,5	48,5	29,84	71		SE	2	Cloudy.
	2	o	38	49	29,65	79		SSW	2	Rain.
6	8	o	34	48,5	29,94	74	0,100	W	1	Fair.
	2	o	39,5	50,5	30,06	70		WNW	1	Fine.
7	8	o	31	49	30,21	74		SW	1	Cloudy.
	2	o	39	50,5	30,15	74		E	1	Cloudy.
8	8	o	46	50	29,70	86	0,457	W	1	Rain.
	2	o	45	53	29,88	66		WNW	2	Cloudy.
9	8	o	32	49	30,11	76		WNW	1	Fine.
	2	o	38	51	30,12	75		WNW	1	Fair.
10	8	o	40,5	49	29,85	80		SSE	2	Cloudy.
	2	o	47,5	51,5	29,71	83		S	2	Cloudy.
11	8	o	43,5	51	29,54	79	0,053	SSW	2	Cloudy.
	2	o	46	54	29,56	71		SSW	2	Cloudy.
12	8	o	42	51	28,98	75	0,380	SSW	3	Rain.
	2	o	43	53	29,11	67		WSW	2	Cloudy.
13	8	o	37	50	29,34	76	0,053	SW	1	Cloudy.
	2	o	44	52	29,34	71		SW	1	Cloudy.
14	8	o	38	50,5	29,55	79		NE	1	Cloudy.
	2	o	42	51,5	29,68	72		NE	2	Cloudy.
15	8	o	36	50	30,00	73		NE	2	Cloudy.
	2	o	38	50,5	30,07	69		NE	2	Cloudy.
16	8	o	33,5	48	30,24	68		NE	2	Cloudy.
	2	o	35	48	30,27	64		NE	2	Cloudy.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Jan. 17	8	0	36	48	30,25	*		NW	1	Rain.
	2	0	37	50	30,27			NE	2	Cloudy.
18	8	0	33,5	48	30,46			ENE	2	Cloudy.
	2	0	36	48,5	30,47			E	2	Fine.
19	8	0	28	45	30,52			NE	1	Fine.
	2	0	33	47	30,51			NE	1	Hazy.
20	8	0	32	46,5	30,49			WNW	1	Cloudy.
	2	0	34	47	30,50			NW	1	Cloudy.
21	8	0	31	47	30,50			WNW	1	Cloudy.
	2	0	37	48	30,50			W	1	Cloudy.
22	8	0	35	46	30,50			W	1	Foggy.
	2	0	39	49,5	30,52			W	1	Cloudy.
23	8	0	33	47	30,47			W	1	Cloudy.
	2	0	36	48	30,41			SW	1	Cloudy.
24	8	0	39	47	30,22			W	1	Cloudy.
	2	0	43	50	30,15			W	1	Rain.
25	8	0	39	49	30,00		0,378	E	1	Rain.
	2	0	41	51	30,07			NE	1	Cloudy.
26	8	0	31	48	30,23					Foggy.
	2	0	37	50	30,24			E	1	Fair.
27	8	0	33	47,5	30,30			W	1	Cloudy.
	2	0	41	50,5	30,30			W	1	Cloudy.
28	8	0	39	48	30,18			W	1	Cloudy.
	2	0	48	52,5	30,16			W	1	Fine.
29	8	0	40	49	30,00			W	1	Foggy.
	2	0	46	52	29,91			SW	1	Cloudy.
30	8	0	39	50,5	29,80		0,017	WNW	1	Cloudy.
	2	0	43	52	29,82			NW	1	Fine.
31	8	0	36	50	29,88			WNW	2	Fair.
	2	0	44	52	29,87			NW	2	Fair.

* This interruption, in the observations of the hygrometer, was occasioned by one end of the whalebone having slipped out of the pincers by which it is held.

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1793	Time.		Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds.		Weather.
	H.	M.	o	o	Inches.		Inches.	Points.	Str.	
Feb. 1	7	o	41,5	50	29,50			S	2	Cloudy.
	2	o	43	52,5	29,37			S	2	Cloudy.
2	7	o	37,5	50	29,59			W	2	Fine.
	2	o	45	53	29,53			SW	2	Cloudy.
3	7	o	43	51,5	29,34		0,246	SW	2	Cloudy.
	2	o	44	54	29,36	61		SW	2	Fair.
4	7	o	39	50,5	29,32	69	0,053	SW	2	Cloudy.
	2	o	43,5	53	29,29	64		SSW	2	Fair.
5	7	o	37	50,5	29,33	72		WNW	1	Foggy.
	2	o	43	55	29,49	67		WNW	1	Fair.
6	7	o	39	51	29,61	74	0,112	W	1	Rain.
	2	o	46	53,5	29,62	62		W	1	Cloudy.
7	7	o	41	50,5	29,57	75	0,278	W	1	Cloudy.
	2	o	43	53,5	29,72	63		WNW	1	Hazy.
8	7	o	38	50,5	29,85	68		WSW	2	Cloudy.
	2	o	43	53	29,60	71		SW	1	Cloudy.
9	7	o	39	50 5	29,78	69	0,290	WNW	1	Cloudy.
	2	o	46	53	29,79	63		W	1	Cloudy.
10	7	o	36	50	29,53	65	0,097	W	2	Fine.
	2	o	40	52	29,52	60		WNW	2	Cloudy.
11	7	o	36,5	49,5	29,58	63	0,037	WNW	2	Fine.
	2	o	42,5	52	29,78	59		WNW	2	Fair.
12	7	o	44	50,5	29,52	63	0,031	NW	2	Cloudy.
	2	o	48	54	29,58	55		NW	2	Cloudy.
13	7	o	39	51	29,92	68		WNW	2	Cloudy.
	2	o	51	54	29,88	74		WSW	1	Cloudy.
14	7	o	47	53	29,67	76		SW	2	Cloudy.
	2	o	44,5	53,5	29,75	64		W	2	Fair.
15	7	o	38,5	52	29,66	75	0,286	SW	2	Rain.
	2	o	41,5	53	29,71	63		SE	1	Cloudy.
16	7	o	35	51	29,78	70		N	2	Cloudy.
	2	o	40,5	53	29,85	65		NNE	2	Fair.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Feb. 17	7	0	34	50,5	30,05	75		NNE	1	Cloudy.
	2	0	41	52,5	30,04	67		NE	1	Cloudy.
18	7	0	37	51	29,80	73		W	1	Fair.
	2	0	43	53	29,77	73		W	1	Cloudy.
19	7	0	32,5	50	30,01	71	0,031	W	1	Fair.
	2	0	43	53	30,05	64		NW	1	Fair.
20	7	0	32	50	30,18	72		WNW	1	Fine.
	2	0	43	54	30,17	64		SW	1	Fine.
21	7	0	37	51	30,11	74		SSW	1	Fine.
	2	0	46	53,5	30,10	64		S	2	Fair.
22	7	0	30	50	30,21	73		S by W	1	Foggy.
	2	0	44	54	30,21	63		SW	1	Fine.
23	7	0	45	52	30,15	80		WSW	1	Cloudy.
	2	0	50	55	30,18	70		WSW	2	Cloudy.
24	7	0	47	53	30,16	77	0,120	W	1	Cloudy.
	2	0	52	57	30,22	65		SWb.S	2	Cloudy.
25	7	0	43,6	53	30,05	78		SWb.S	2	Cloudy.
	2	0	47	57	29,85	72		SWb.S	2	Cloudy.
26	7	0	40	53	29,95	67		WNW	2	Fine.
	2	0	47	56	30,13	52		NW	2	Fair.
27	7	0	42,5	54	30,02	64		SW	2	Cloudy.
	2	0	50	56	29,97	58		SSW	2	Fair.
28	7	0	42,5	54	29,87	72		SW	2	Cloudy.
	2	0	48	56,5	29,96	58		W	2	Fair.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Mar. 1	7	0	43	54,5	29,73	68		SSW	2	Fair.
	2	0	46	56	29,52	70		SSW	2	Cloudy.
2	7	0	42	54	29,70	67	0,095	W	1	Cloudy.
	2	0	51	56,5	29,69	64		SW	2	Cloudy.
3	7	0	41	54	29,62	60	0,063	W	2	Fine.
	2	0	47	56	29,77	51		WNW	2	Fine.
4	7	0	35	53	29,88	68		WNW	2	Fine.
	2	0	45	56	29,89	55		WNW	2	Fair.
5	7	0	35	53	29,78	67		E	1	Cloudy.
	2	0	46	55	29,76	60		ESE	2	Cloudy.
6	7	0	39	53	29,91	70		N	2	Fine.
	2	0	46,5	55,5	29,96	62		NNE	2	Cloudy.
7	7	0	35,5	52	30,02	72		NNE	1	Fine.
	2	0	44	55	30,05	59		NE	2	Fair.
8	7	0	37	52	30,19	60		E	2	Cloudy.
	2	0	42	56	30,21	51		E	2	Fine.
9	7	0	37	51	30,12	61		E	2	Cloudy.
	2	0	41	53,5	30,05	55		E	2	Fair.
10	7	0	34	51,5	29,96	61		ENE	1	Fair.
	2	0	40,5	53	29,92	57		E	2	Fair.
11	7	0	36	50	29,76	60		E	2	Cloudy.
	2	0	37,5	52	29,74	58		E	2	Cloudy.
12	7	0	33,5	49,5	29,86	57		E	2	Cloudy.
	2	0	36	51	29,90	56		E	2	Fine.
13	7	0	45	50,5	29,80	83	0,100	SW	2	Cloudy.
	2	0	51	54	29,93	74		SSW	2	Cloudy.
14	7	0	43	52	30,13	80		SW	1	Cloudy.
	2	0	51	55	30,15	55		SSW	1	Fair.
15	7	0	36	53	30,09	72		SWb.W	1	Cloudy.
	2	0	49	57,5	30,02	56		SSW	1	Fine.
16	7	0	44	55	29,86	71		SSW	2	Cloudy.
	2	0	49	58	29,60	57		S	2	Cloudy.

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1793	Time. H.	Time. M.	Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds. Points.	Winds. Str.	Weather.
			o	o	Inches.		Inches.			
Mar. 17	7	o	35,5	55	29,62	69	0,183	WSW	1	Fine.
	2	o	45,5	56	29,42	63		ESE	1	Hazy.
18	7	o	44	55,5	29,07	80	0,241	S	1	Cloudy.
	2	o	49	57,5	29,20	62		S	2	Cloudy.
19	7	o	38.5	54,5	29,70	68	0,015	WSW	1	Cloudy.
	2	o	48,5	57	29,78	60		W	1	Cloudy.
20	7	o	46	54,5	29,84	76		SW	1	Cloudy.
	2	o	52	58	29,82	65		SSW	2	Cloudy.
21	7	o	47	55,5	29,84	75	0,020	WSW	1	Cloudy.
	2	o	48	58	29.92	65		SW	1	Cloudy.
22	7	o	42	55	29,72	70		SSE	2	Cloudy.
	2	o	43	56,5	29,60	72		S	2	Rain.
23	7	o	37	54.5	29,78	70	0,325	W	1	Fair.
	2	o	46	57	29,78	53		SSW	1	Fair.
24	7	o	36	54	29,90	66		NE	1	Fine.
	2	o	43	55,5	29,91	67		NE	2	Cloudy.
25	7	o	41,5	53	29,98	74	0,023	ENE	2	Cloudy.
	2	o	44,5	55	30,01	64		NE	2	Cloudy.
26	7	o	36,5	52	29,94	78	0,097	NE	2	Rain.
	2	o	40	52	29,91	68		NE	2	Cloudy.
27	7	o	34,5	50,5	30,02	61		NE	2	Cloudy.
	2	o	39	53	29,97	56		NE	2	Cloudy.
28	7	o	34	50,5	29,76	62		NE	1	Cloudy.
	2	o	41	55	29,50	51		E	2	Fair.
29	7	o	33	50,5	29,83	65		NE	2	Cloudy.
	2	o	41,5	54	29,86	51		NE	2	Fair.
30	7	o	33	50	29,98	60		NE	1	Fine.
	2	o	43,5	54.5	29,98	51		NW	1	Fair.
31	7	o	33	51	29,99	67		N	1	Fair.
	2	o	42	53,5	29,94	52		N	1	Fine.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Apr. 1	7	0	36	50	29,77	64	0,025	SSE	2	Cloudy.
	2	0	36,5	51,5	29,63	70		E	1	Rain.
2	7	0	36	50	29,56	75	0,383	WNW	1	Snow.
	2	0	40,5	52	29,68	70		WNW	1	Cloudy.
3	7	0	35	50,5	29,88	73		W	1	Fair.
	2	0	48	54,5	29,91	51		SW	1	Fair.
4	7	0	39	51	30,00	71		NNE	1	Cloudy.
	2	0	51,5	54	30,00	58		N	1	Cloudy.
5	7	0	42	52	30,00	70		NNW	1	Hazy.
	2	0	52	57	30,00	60		N	1	Fine.
6	7	0	41	53,5	30,04	73		NNW	1	Cloudy.
	2	0	54	58	30,04	64		NNE	1	Fine.
7	7	0	40	54,5	30,16	67		NNE	1	Fine.
	2	0	51	58	30,19	56		E	1	Fine.
8	7	0	40	54	30,30	66		ENE	1	Hazy.
	2	0	50,5	57	30,30	47		E	1	Fine.
9	7	0	39	53,5	30,27	66		E	1	Fine.
	2	0	49	59	30,24	47		E	2	Fine.
10	7	0	37	53	30,21	65		ENE	2	Fine.
	2	0	46	55,5	30,16	49		NE	2	Cloudy.
11	7	0	37	53	30,08	64		NNW	1	Fair.
	2	0	45	54,5	29,96	64		NW	1	Cloudy.
12	7	0	39,5	53	29,88	68		NNE	1	Cloudy.
	2	0	44	54	29,88	61		NE	1	Cloudy.
13	7	0	37	52	29,76	68	0,040	NE	1	Fine.
	2	0	49	56	29,70	54		NE	1	Fair.
14	7	0	43	53,5	29,74	67		W	1	Cloudy.
	2	0	46	55	29,82	57		NNE	2	Cloudy.
15	7	0	33	52	29,94	59		W	1	Cloudy.
	2	0	50	54	29,81	52		W	2	Cloudy.
16	7	0	38	53	29,64	66	0,038	NW	2	Cloudy.
	2	0	45	54	29,76	47		N	2	Cloudy.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Apr. 17	7	0	34	51	30,07	63		W	1	Fine.
	2	0	40	52	30,00	60		SSW	2	Rain.
18	7	0	47	52	29,27	85	0,543	WSW	1	Cloudy.
	2	0	53,5	54,5	29,22	63		W	2	Cloudy.
19	7	0	42	53,5	29,58	63	0,066	NW	2	Cloudy.
	2	0	43	54,5	29,86	64		N	2	Cloudy.
20	7	0	36	53	30,19	66		NW	1	Fair.
	2	0	48	55,5	30,22	52		N	1	Fair.
21	7	0	42	53	30,15	57		SSE	1	Cloudy.
	2	0	54,5	57	30,15	51		S	1	Fine.
22	7	0	43	54	30,20	60		E	1	Fine.
	2	0	54,5	57	30,18	46		E	1	Fine.
23	7	0	44	55	29,88	63		E	1	Fine.
	2	0	59	58,5	29,79	48		ESE	1	Hazy.
24	7	0	48	56,5	29,70	63		NE	1	Cloudy.
	2	0	60	59,5	29,70	53		E	1	Fine.
25	7	0	47	57,5	29,76	70		N	1	Cloudy.
	2	0	53	58	29,79	60		N	1	Cloudy.
26	7	0	47	57,5	29,85	67		W	1	Cloudy.
	2	0	58	59	29,78	53		SSW	1	Cloudy.
27	7	0	47	57	29,57	63		E	1	Cloudy.
	2	0	56	58,5	29,55	56		E	1	Cloudy.
28	7	0	46	57	29,75	62		NE	1	Cloudy.
	2	0	57	59,5	29,80	55		NW	1	Hazy.
29	7	0	45	58	29,88	65		S	1	Fair.
	2	0	52,5	59,5	29,77	60		S	2	Cloudy.
30	7	0	46	57,5	29,77	66		WSW	2	Fine.
	2	0	57	59,5	29,68	54		SW	2	Cloudy.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
May 1	7	0	48	58,5	29,27	66	0,090	SW	2	Cloudy.
	2	0	57	59,5	29,24	57		SW	2	Cloudy.
2	7	0	48	57	29,36	65	0,065	SW	2	Cloudy.
	2	0	53,5	61	29,50	64		WSW	2	Cloudy.
3	7	0	44	57,5	30,04	68	0,284	WNW	1	Fine.
	2	0	56	59	30,15	60		WNW	1	Fair.
4	7	0	45	57	30,29	68		W	1	Fair.
	2	0	54	59	30,25	52		WSW	1	Cloudy.
5	7	0	50	58	29,90	65		W	1	Cloudy.
	2	0	54	58	30,07	49		NW	1	Cloudy.
6	7	0	45	57	30,29	61		NW	1	Fine.
	2	0	59	59,5	30,28	49		NW	1	Cloudy.
7	7	0	47	57,5	30,17	64		N	1	Cloudy.
	2	0	53,5	58	30,15	60		N	1	Cloudy.
8	7	0	44	58	30,14	68	0,100	E	1	Cloudy.
	2	0	58	59,5	30,08	56		SSE	1	Cloudy.
9	7	0	47	58	30,05	70	0,165	SW	1	Cloudy.
	2	0	61	61,5	30,11	50		WSW	1	Fair.
10	7	0	48	59	30,18	64		W	1	Cloudy.
	2	0	55,5	59,5	30,06	57		SSE	1	Cloudy.
11	7	0	52	59	29,78	64		E	1	Fair.
	2	0	60	60	29,77	56		E	1	Hazy.
12	7	0	55,5	59,5	29,89	68		NNE	1	Fine.
	2	0	66	60	29,93	60		E	1	Fine.
13	7	0	53	60	29,92	67		NE	1	Cloudy.
	2	0	69	64	29,93	53		NNE	1	Fine.
14	7	0	51	61	30,11	61		N	1	Fine.
	2	0	61	62	30,16	47		NNE	1	Fine.
15	7	0	52	59	30 14	58		NW	1	Hazy.
	2	0	63,5	60,5	30,17	55		NW	1	Cloudy.
16	7	0	52	58	30,26	58		N	1	Fine.
	2	0	61	59,5	30,23	47		NW	1	Fine.

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1793	Time. H.	M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Str.	Weather.
May 17	7	0	55	60,5	30,09	65		WNW	1	Cloudy.
	2	0	65	62	29,93	60		WNW	1	Cloudy.
18	7	0	52	61	29,98	65	0,161	NE	1	Cloudy.
	2	0	61	61	30,01	58		NNE	1	Cloudy.
19	7	0	48	59,5	30,06	59		N	1	Cloudy.
	2	0	54	59	30,06	58		NNE	2	Cloudy.
20	7	0	48	57	30,11	62		NNE	1	Fair.
	2	0	61	60,5	30,10	49		NE	1	Fine.
21	7	0	50	59	30,15	61		N	1	Fine.
	2	0	65,5	61,5	30,15	50		N	1	Fine.
22	7	0	49	59,5	30,23	56		N	2	Cloudy.
	2	0	57	59,5	30,23	55		N	2	Cloudy.
23	7	0	51	57,5	30,22	61		N	2	Fair
	2	0	63	60	30,22	55		E	1	Fine.
24	7	0	50	59	30,21	64		N	1	Cloudy.
	2	0	57	61	30,18	52		NW	1	Fair.
25	7	0	48	58	30,26	60		N	1	Fine.
	2	0	61	59	30,26	45		N	1	Fine.
26	7	0	51	58,5	30,29	49		NNE	1	Fine.
	2	0	63	61	30,25	45		NNE	1	Cloudy.
27	7	0	49	58	30,22	60		N	1	Cloudy.
	2	0	69	59,5	30,12	50		NW	1	Hazy.
28	7	0	52	59	29,97	64		WNW	1	Cloudy.
	2	0	64	60	29,88	51		NW	1	Fair.
29	7	0	48	58,5	29,85	58		W	1	Cloudy.
	2	0	53	58	29,85	45		WNW	1	Fair.
30	7	0	46	57	29,82	55		W	2	Fine.
	2	0	58	57	29,91	43		NW	2	Fine.
31	7	0	46	56	30,13	50		NW	1	Fine.
	2	0	58	58	30,15	45		NW	1	Cloudy.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
June 1	7	0	47	57	30,16	56		WSW	1	Fine.
	2	0	65	58,5	30,05	46		SW	2	Hazy.
2	7	0	54	57	29,82	52		SE b. E	2	Cloudy.
	2	0	63	58	29,80	48		SE	2	Cloudy.
3	7	0	54	58	29,94	63		SW	1	Fair.
	2	0	67,5	61	30,01	50		S by W	2	Fair.
4	7	0	58	59,5	30,09	55		S by W	2	Fair.
	2	0	70	61,5	30,05	49		S by W	2	Cloudy.
5	7	0	57,5	60,5	30,05	58		E	1	Hazy.
	2	0	67	62	30,05	54		SSW	1	Cloudy.
6	7	0	56	61,5	30,02	60		SSW	1	Fair.
	2	0	64	63	30,00	57		SSW	2	Cloudy.
7	7	0	56	61,5	29,93	66		WSW	2	Cloudy.
	2	0	70	63	29,89	48		WSW	1	Fine.
8	7	0	55	62	29,86	62		WSW	2	Cloudy.
	2	0	65	63	29,91	57		SW b. W	2	Cloudy.
9	7	0	54	62	30,01	60		SSW	2	Fair.
	2	0	65	62,5	30,01	54		SSW	2	Cloudy.
10	7	0	52	61,5	30,09	60		W	2	Fair.
	2	0	67,5	63	30,10	48		W	2	Fair.
11	7	0	52	61	30,10	64		W	1	Fair.
	2	0	64	62	30,04	51		SW	1	Fair.
12	7	0	52	61,5	29,94	59		WSW	1	Fine.
	2	0	62	62	30,00	53		NW	1	Cloudy.
13	7	0	54	61	30,13	60		NW	1	Hazy.
	2	0	59	61	30,15	52		NE	2	Cloudy.
14	7	0	50	59,5	30,20	60		NNE	1	Cloudy.
	2	0	57	60	30,19	55		N	1	Cloudy.
15	7	0	50	59	30,14	58		N	1	Cloudy.
	2	0	61	60	30,15	52		WNW	1	Fair.
16	7	0	54	59,5	30,12	58		NW	1	Fair.
	2	0	65	60	30,07	52		NW	1	Cloudy.

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1793	Time.		Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds.		Weather.
	H.	M.	o	o	Inches.		Inches.	Points.	Str.	
June 17	7	o	57	60	29,86	63	0,030	W	1	Cloudy.
	2	o	70	61,5	29,83	50		WNW	2	Fair.
18	7	o	52	60	29,94	54		NW	2	Fine.
	2	o	63	60	29,96	50		NW	1	Fair.
19	7	o	54	60	29,71	65	0,198	W	1	Rain.
	2	o	60	60	29,68	64		NW	1	Cloudy.
20	7	o	52	59,5	29,90	60	0,088	NW	1	Cloudy.
	2	o	55	58,5	29,97	57		NW	1	Cloudy.
21	7	o	52	59	30,07	56		E	1	Cloudy.
	2	o	66	60	30,04	50		W	1	Fair.
22	7	o	52	59	29,78	59		WNW	1	Cloudy.
	2	o	62	60,5	29,79	50		WNW	1	Cloudy.
23	7	o	50	59	29,95	54		WNW	1	Fine.
	2	o	64	61	29,98	47		WNW	1	Fine.
24	7	o	51	59	29,97	59		W	1	Cloudy.
	2	o	58	59,5	29,91	60		W	1	Cloudy.
25	7	o	56	59,5	29,88	63	0,025	W	1	Fair.
	2	o	63	60	29,91	55		SW	1	Cloudy.
26	7	o	58	60,5	29,78	72	0,066	WSW	1	Cloudy.
	2	o	72	62,5	29,78	47		WNW	1	Fair.
27	7	o	54	60,5	29,73	63		W	1	Fine.
	2	o	70	62	29,81	48		W	1	Fine.
28	7	o	57	61,5	29,84	65		WSW	1	Fair.
	2	o	67	62	29,90	48		SW	2	Cloudy.
29	7	o	57	62	29,80	65		S	2	Cloudy.
	2	o	65	62	29,73	63		SSW	2	Cloudy.
30	7	o	57	62,5	29,90	61	0,020	SW	2	Fine.
	2	o	64	63	29,90	56		SW	2	Cloudy.

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1793	Time.	Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds.		Weather.
	H. M.	°	°	Inches.		Inches.	Points.	Str.	
July 1	7 0	57	62,5	29,85	62		SW	2	Cloudy.
	2 0	67	63	29,85	63		SW	2	Cloudy.
2	7 0	56	62	30,04	62	0,070	WSW	2	Fair.
	2 0	68	63	30,09	49		W	2	Fair.
3	7 0	54	62	30,23	61		W	1	Fine.
	2 0	74	63	30,22	48		W	1	Cloudy.
4	7 0	57	62	30,18	56		SW	2	Cloudy.
	2 0	71	63,5	30,12	49		SW	2	Fair.
5	7 0	60	64	30,16	61		WSW	2	Fine.
	2 0	80,5	66,5	30,20	48		W	2	Fine.
6	7 0	60	66	30,30	66		W	2	Fair.
	2 0	86	68,5	30,26	51		SSW	1	Fine.
7	7 0	65	69	30,14	62		SW	1	Fine.
	2 0	89	72	30,08	48		SW b.S	1	Fine.
8	7 0	66	72	30,09	61		E	1	Hazy.
	2 0	80	73,5	30,08	52		E	1	Fine.
9	7 0	62	71	30,10	62		E	2	Cloudy.
	2 0	74	72,5	30,08	54		E	1	Fine.
10	7 0	66	71	30,07	59		E	1	Hazy.
	2 0	82,5	73	30,07	43		E	1	Fine.
11	7 0	67	72	30,01	56		E	1	Cloudy.
	2 0	80	74,5	29,96	49		E	1	Fine.
12	7 0	66	72	29,98	56		E	1	Fine.
	2 0	83	76	30,00	45		E	1	Fine.
13	7 0	65	73,5	30,10	58		NE	1	Hazy.
	2 0	82	76	30,11	46		E	1	Fine.
14	7 0	62	73	30,18	53		NE	1	Hazy.
	2 0	79	76	30,16	47		E	1	Fine.
15	7 0	65	73	30,17	50		NE	1	Hazy.
	2 0	83,5	75	30,10	43		E	1	Fine.
16	7 0	66	73,5	29,96	50		E	1	Hazy.
	2 0	89	76	29,85	45		SW	1	Fine.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
July 17	7	0	65	74	29,82	53		SSW	1	Fine.
	2	0	80	74	29,88	49		WSW	1	Fair.
18	7	0	62	73	29,85	55	0,049	SW	1	Cloudy.
	2	0	67	72	29,76	53		WSW	1	Cloudy.
19	7	0	60	70	29,76	58	0,064	WSW	2	Cloudy.
	2	0	68	70	29,74	47		SSW	2	Cloudy.
20	7	0	57	68	29,85	57		WNW	1	Cloudy.
	2	0	65	68	29,93	53		NW	1	Cloudy.
21	7	0	56	67	30,20	56	0,070	NNW	1	Cloudy.
	2	0	67	67	30,21	48		NW	1	Cloudy.
22	7	0	56	66	30,21	58		S	2	Fair.
	2	0	73,5	67	30,14	48		S by W	2	Hazy.
23	7	0	60	66	30,01	60		SSW	2	Cloudy.
	2	0	63	66,5	29,98	59		SSW	2	Rain.
24	7	0	64	66	30,00	62	0,011	WSW	1	Cloudy.
	2	0	78	69	30,01	51		W	1	Cloudy.
25	7	0	65	68	30,01	65		W	1	Cloudy.
	2	0	75	69	30,01	56		W	1	Fair.
26	7	0	63	68,5	30,06	60		W	1	Cloudy.
	2	0	75	70	30,06	52		W	1	Cloudy.
27	7	0	64	69	30,00	64		E	1	Cloudy.
	2	0	63	69	29,98	69		ENE	1	Rain.
28	7	0	59	67,5	29,92	74	1,137	NNE	1	Cloudy.
	2	0	64	67	29,91	59		N	1	Cloudy.
29	7	0	56	65	29,91	65		NW	1	Cloudy.
	2	0	67,5	66	29,92	53		NW	1	Fair.
30	7	0	56	65,5	29,97	65		WNW	1	Fine.
	2	0	71	66,5	29,96	52		SW	2	Fair.
31	7	0	60	66	29,91	68	0,215	SSW	2	Rain.
	2	0	71	67	29,95	51		SW	2	Fair.

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1793	Time. H.	Time. M.	Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds.		Weather.
			°	°	Inches.		Inches.	Points.	Str.	
Aug. 1	7	0	58	66	30,16	66		W	1	Fine.
	2	0	74,5	67	30,18	49		W	1	Fine.
2	7	0	61	66,5	30,17	61		N	1	Fine.
	2	0	75	68,5	30,08	51		E	1	Fair.
3	7	0	64	67	29,86	68		E	2	Fair.
	2	0	78,5	70,5	29,78	58		SSE	2	Fair.
4	7	0	62	68,5	29,70	67	0,358	WSW	1	Cloudy.
	2	0	65	68,5	29,71	53		S	2	Cloudy.
5	7	0	60	67,5	29,92	66		W	2	Cloudy.
	2	0	72,5	69	29,85	54		SSW	2	Fair.
6	7	0	58	67	30,06	65	0,158	W	2	Fine.
	2	0	70,5	68	30,14	50		WNW	2	Fair.
7	7	0	59	67,5	30,17	64		E	1	Fine.
	2	0	68	68	30,03	53		E	2	Cloudy.
8	7	0	60	67	29,84	73	0,257	SW	2	Cloudy.
	2	0	73	68	29,81	50		SW	2	Fair.
9	7	0	60	66	29,80	63		SW	2	Cloudy.
	2	0	67	67	29,80	53		SW	2	Fair.
10	7	0	62	66	29,80	59		SW	2	Cloudy.
	2	0	67	67	29,88	53		SW	2	Fair.
11	7	0	56	66	30,08	64		SW	1	Fine.
	2	0	69	66,5	30,06	47		SW	1	Hazy.
12	7	0	59	66	30,07	60		WSW	1	Cloudy.
	2	0	74	68	30,04	49		S	1	Fine.
13	7	0	63	67	29,92	58		E	1	Cloudy.
	2	0	80	70	29,85	51		SSW	2	Fair.
14	7	0	56	67	30,03	61		WSW	2	Fine.
	2	0	72	68	29,96	47		WSW	1	Cloudy.
15	7	0	58,5	67	29,69	61		S	1	Cloudy.
	2	0	68	67	29,44	57		S	2	Cloudy.
16	7	0	57	65,5	29,63	63		W	2	Fine.
	2	0	68	67	29,72	49		W	2	Fair.

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1793	Time. H.	Time. M.	Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds. Points.	Winds. Str.	Weather.
			o	o	Inches.		Inches.			
Aug. 17	7	0	57	65	29,58	66		E	1	Cloudy.
	2	0	58	65,5	29,34	63		S	2	Rain.
18	7	0	54	64	29,73	66	0,460	WNW	2	Cloudy.
	2	0	61	64,5	29,94	57		WNW	2	Cloudy.
19	7	0	52	63,5	30,10	67		WSW	1	Cloudy.
	2	0	67	65	30,10	55		S	1	Fair.
20	7	0	53	63,5	30,18	65		S	1	Fine.
	2	0	69,5	65	30,20	50		S	1	Fine.
21	7	0	58	64	30,28	68		S	1	Fine.
	2	0	74	66,5	30,28	54		S	1	Fine.
22	7	0	57	65	30,21	68		S	1	Hazy.
	2	0	75,5	67	30,13	52		SW	1	Fair.
23	7	0	62	66	30,01	68		W	1	Cloudy.
	2	0	71,5	68	30,01	50		SW	1	Hazy.
24	7	0	55	65,5	30,09	63		SW	1	Fair.
	2	0	67	66,5	30,07	50		SW	1	Hazy.
25	7	0	54	65	30,18	62		SW	1	Fine.
	2	0	65,5	65	30,18	51		E	1	Hazy.
26	7	0	53	64	30,10	64		NE	1	Hazy.
	2	0	68,5	67	30,00	50		SW	1	Hazy.
27	7	0	53	64,5	29,94	63		WSW	1	Fine.
	2	0	67	65	29,94	48		WNW	1	Cloudy.
28	7	0	55	64	30,04	67		W	1	Hazy.
	2	0	67,5	65	30,14	53		W	1	Hazy.
29	7	0	57	64	30,05	60		NE	1	Cloudy.
	2	0	68,5	66	29,99	52		SSW	1	Fine.
30	7	0	57,5	65	29,80	66		SSW	1	Cloudy.
	2	0	66	66	29,73	60		SSW	2	Cloudy.
31	7	0	56	65	29,77	63	0,082	NW	2	Cloudy.
	2	0	65	65	29,75	56		W	2	Fair.

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1793	Time. H.	Time. M.	Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds. Points.	Winds. Str.	Weather.
			o	o	Inches.		Inches.			
Sep. 1	7	o	53	64	29,87	64		WSW	2	Cloudy.
	2	o	56	64	29,71	69		SSW	2	Rain.
2	7	o	55	63,5	29,66	71	0,309	WSW	1	Cloudy.
	2	o	64	64,5	29,59	59		W	2	Fair.
3	7	o	56	63	29,58	61		WNW	2	Fair.
	2	o	66	64,5	29,76	60		WNW	2	Fair.
4	7	o	48	62,5	29,98	63		WNW	2	Fair.
	2	o	64	63	30,05	50		WNW	2	Fair.
5	7	o	46	62	30,09	63		WNW	1	Fine.
	2	o	59	62	30,08	53		WNW	1	Fair.
6	7	o	49	61	30,07	61		W	1	Cloudy.
	2	o	60,5	63	30,05	59		W	1	Cloudy.
7	7	o	42	59	30,20	62	0,030	W	1	Fine.
	2	o	60	62	30,26	51		W	1	Fine.
8	7	o	54	61	30,31	74		W	1	Cloudy.
	2	o	66	62	30,32	59		W	1	Cloudy.
9	7	o	54	61	30,31	67		W	1	Cloudy.
	2	o	63	62	30,26	56		W	1	Cloudy.
10	7	o	53	61	30,11	67		W	1	Cloudy.
	2	o	66	62	30,10	59		W	1	Cloudy.
11	7	o	48	61,5	30,10	67		W	1	Foggy.
	2	o	62	62	30,05	62		W	1	Fair.
12	7	o	53	62	30,02	68		E	1	Foggy.
	2	o	66,5	64	29,95	60		E	1	Fine.
13	7	o	59	63	29,88	73	0,153	W	1	Cloudy.
	2	o	64	64	29,83	66		SW	1	Rain.
14	7	o	57	63	29,79	72	0,260	SSE	1	Fair.
	2	o	65,5	64,5	29,71	61		SSE	2	Cloudy.
15	7	o	57	64	29,41	80	0,680	SW	1	Rain.
	2	o	63,5	66	29,53	58		SW	1	Fair.
16	7	o	52	63	29,59	71	0,198	WNW	1	Fair.
	2	o	62	64	29,68	61		WNW	1	Fair.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Sep. 17	7	0	49	62,5	29,96	72		WSW	1	Fine.
	2	0	62,5	63,5	29,98	60		S	2	Cloudy.
18	7	0	60	63,5	29,77	82	0,277	SSW	1	Cloudy.
	2	0	64	64	29,78	76		SSW	1	Cloudy.
19	7	0	53	62,5	30,12	71	0,120	NE	1	Cloudy.
	2	0	57	62	30,16	63		NE	1	Cloudy.
20	7	0	52	61	30,10	72		NE	1	Cloudy.
	2	0	58	62	30,13	57		NE	1	Fair.
21	7	0	46	60	30,18	67	0,040	ENE	2	Fine.
	2	0	51	61	30,17	65		NE	2	Cloudy.
22	7	0	46	59	29,88	70	0,047	NE	2	Cloudy.
	2	0	51,5	58	29,72	69		NE	1	Cloudy.
23	7	0	44	57	29,55	71	0,099	SE	2	Cloudy.
	2	0	48	57	29,62	65		S	2	Rain.
24	7	0	46	56	29,98	73	0,098	SW	1	Cloudy.
	2	0	58	57,5	30,06	61		SSW	1	Cloudy.
25	7	0	47	56,5	30,22	75	0,141	NW	1	Fair.
	2	0	59	58,5	30,28	59		E	1	Fine.
26	7	0	44	57	30,45	73		ENE	1	Cloudy.
	2	0	58	59	30,45	62		E	1	Fine.
27	7	0	45	57	30,44	74		E	1	Fine.
	2	0	58	59	30,36	62		E	1	Fine.
28	7	0	49	58,5	30,20	77		ENE	1	Fair.
	2	0	59,5	60,5	30,07	62		E	1	Fine.
29	7	0	50	58,5	29,80	74		E	1	Cloudy.
	2	0	59	60	29,71	61		SE	1	Cloudy.
30	7	0	52	58,5	29,71	72		SSW	1	Cloudy.
	2	0	58	59,5	29,77	66		SW	1	Cloudy.

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1793	Time.		Therm. without.	Therm. within.	Barom.	Hygrometer.	Rain.	Winds.		Weather.
	H.	M.	o	o	Inches.		Inches.	Points.	Str.	
Oct. 1	7	0	58	59,5	29,55	84	0,118	SSW	2	Rain.
	2	0	61	60	29,52	79		SSW	2	Cloudy.
2	7	0	49	58,5	29,71	69	0,035	WSW	2	Fine.
	2	0	55	60	29,79	59		SW	2	Cloudy.
3	7	0	49	58,5	30,08	73	0,053	SW	2	Cloudy.
	2	0	59,5	59,5	30,14	60		WSW	2	Cloudy.
4	7	0	56	59	30,02	76		SW	2	Cloudy.
	2	0	65	62	30,08	65		SW	2	Fine.
5	7	0	58	61	30,20	77		SW	2	Cloudy.
	2	0	64,5	62,5	30,23	65		W	2	Fair.
6	7	0	57	62	30,20	74		WSW	2	Cloudy.
	2	0	65	62	30,21	64		SW	1	Cloudy.
7	7	0	49	61	30,28	74		SW	1	Cloudy.
	2	0	60,5	62,5	30,22	60		SW	1	Fine.
8	7	0	50	61,5	30,26	73		SSW	1	Fine.
	2	0	61,5	61,5	30,25	61		SW	1	Cloudy.
9	7	0	53	61	30,18	74		SW	1	Cloudy.
	2	0	62	63	30,12	68		SW	1	Fine.
10	7	0	51	61	29,95	74				Foggy.
	2	0	63,5	63,5	29,88	70		SW	1	Fine.
11	7	0	53	62	29,90	69		SW	1	Cloudy.
	2	0	58	62	29,95	63		SW	1	Cloudy.
12	7	0	55	61,5	29,91	78		E	1	Foggy.
	2	0	65	63	29,91	70		E	1	Fine.
13	7	0	57	62	30,03	76		SSE	1	Fine.
	2	0	63,5	64	30,07	59		SSE	1	Fine.
14	7	0	57	62	30,07	71		E	1	Cloudy.
	2	0	61	63	30,19	61		E	1	Fair.
15	7	0	42	61	30,47	62		S	1	Fine.
	2	0	57	62	30,48	61		E	1	Fine.
16	7	0	53	62	30,48	67		NNW	1	Cloudy.
	2	0	61	63	30,3	60		NW	1	Fair.

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for October, 1793.

1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Oct. 17	7	0	50	61	30,28	72		WNW	1	Fair.
	2	0	59	61,5	30,25	66		NNE	1	Cloudy.
18	7	0	48	60,5	30,28	71		SSE	1	Cloudy.
	2	0	55	60,5	30,26	70		NW	1	Cloudy.
19	7	0	52	60	30,21	67		W	1	Cloudy.
	2	0	54	60	30,18	62		W	1	Cloudy.
20	7	0	52	59	30,13	66		W	1	Cloudy.
	2	0	54	59,5	30,12	61		W	1	Cloudy.
21	7	0	47,5	58	30,13	72		WNW	1	Fine.
	2	0	60	60	30,13	60		NW	1	Fine.
22	7	0	53	59	30,18	70		SW	1	Cloudy.
	2	0	55	60	30,22	69		E	1	Cloudy.
23	7	0	50	59	30,27	65		E	1	Cloudy.
	2	0	56	60	30,21	57		E	1	Fair.
24	7	0	45	59	30,04	61		E	1	Fine.
	2	0	52	60	29,92	58		S by W	1	Cloudy.
25	7	0	49	59	29,76	70		SSW	1	Cloudy.
	2	0	53,5	61	29,65	67		S by W	1	Rain.
26	7	0	57	60	29,53	74		SSW	2	Cloudy.
	2	0	58	62	29,50	71		SSW	2	Cloudy.
27	7	0	52	61	29,47	64		SSW	1	Cloudy.
	2	0	57	62	29,47	66		SSW	1	Cloudy.
28	7	0	43	58	29,75	73		WNW	1	Fine.
	2	0	53	62	29,94	60		WNW	1	Fine.
29	7	0	48	59	29,78	70		SW	1	Cloudy.
	2	0	56	60	29,53	60		SW	2	Cloudy.
30	7	0	39	58	29,29	72	0,931	WNW	1	Fine.
	2	0	47	59	29,36	59		WNW	1	Fine.
31	7	0	35,5	56	29,22	73		WNW	1	Fine.
	2	0	44	57,5	29,31	64		WNW	1	Fine.

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for November, 1793.

1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Nov. 1	7	0	37	55	29,58	74		NW	1	Cloudy.
	2	0	43	56	29,68	66		NE	1	Fair.
2	7	0	31	53,5	29,93	70		W	1	Fine.
	2	0	46	56	29,90	65		SE	1	Fair.
3	7	0	46	54	29,60	78	0,326	WSW	1	Cloudy.
	2	0	50,5	57	29,65	61		WSW	1	Fine.
4	7	0	39	54	29,63	70		E	1	Cloudy.
	2	0	45	54,5	29,43	68		E	1	Cloudy.
5	7	0	35	53	29,60	74	0,391	W	1	Fine.
	2	0	46	56	29,65	66		WNW	1	Fine.
6	7	0	39	53,5	29,82	75		NE	1	Fine.
	2	0	47	56	29,90	66		NE	1	Fine.
7	7	0	38	53	29,96	73		NW	1	Fair.
	2	0	45	56	29,96	66		N	1	Cloudy.
8	7	0	36	53	29,90	73		.		Foggy.
	2	0	44	54	29,75	70		E	1	Cloudy.
9	7	0	38	53	29,50	77	0,277	W	1	Fair.
	2	0	48	55	29,48	71		SE	1	Fair.
10	7	0	48	53,5	29,05	83	0,414	W	1	Rain.
	2	0	49,5	57	29,21	68		SW	1	Fine.
11	7	0	45	54	29,19	80	0,093	WNW	1	Cloudy.
	2	0	50	57	29,38	64		WNW	1	Fair.
12	7	0	36	54	29,69	74		NE	1	Fine.
	2	0	48	55	29,53	76		E	1	Cloudy.
13	7	0	48	54,5	29,27	74	0,310	SW	2	Fair.
	2	0	52	56,5	29,28	66		SSW	2	Cloudy.
14	7	0	40	55	29,43	74		SSW	1	Cloudy.
	2	0	54	57	29,49	64		SSW	1	Cloudy.
15	7	0	42	55	29,51	76		E	1	Cloudy.
	2	0	52	57	29,48	70		ESE	1	Cloudy.
16	7	0	46	56	29,44	75		E	1	Cloudy.
	2	0	48	57	29,48	72		E	1	Cloudy.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Nov. 17	7	0	47	57	29,67	83	0,236	E	1	Cloudy.
	2	0	50	58	29,66	78		E	1	Rain.
18	7	0	50	56,5	29,59	75	0,057	E	1	Cloudy.
	2	0	56	59	29,65	71		E	1	Cloudy.
19	7	0	47	58	29,57	80		E	1	Foggy.
	2	0	56	60	29,59	70		E	1	Fine.
20	7	0	45	58	29,82	78		ENE	1	Cloudy.
	2	0	52	59,5	29,86	75		E	1	Cloudy.
21	7	0	47	58	30,01	75		E	1	Cloudy.
	2	0	52	59,5	30,01	67		E	1	Fair.
22	7	0	43	57	29,99	74		ENE	1	Cloudy.
	2	0	51,5	60,5	29,96	75		E	1	Fine.
23	7	0	45	58,5	29,94	78		E	1	Foggy.
	2	0	50,5	61	29,93	70		E	1	Fine.
24	7	0	45	58	30,10	73		E	1	Cloudy.
	2	0	47	59	30,14	71		E	1	Cloudy.
25	7	0	45	58	30,30	74		E	1	Cloudy.
	2	0	47	58,5	30,32	66		E	1	Cloudy.
26	7	0	44	57	30,33	70		E	1	Cloudy.
	2	0	46,5	58	30,31	70		E	1	Cloudy.
27	7	0	43	57	30,25	75		NE	1	Fair.
	2	0	48	57,5	30,24	73		NNE	1	Cloudy.
28	7	0	45	57	30,30	78		NE	1	Foggy.
	2	0	45	57	30,31	72		ENE	1	Cloudy.
29	7	0	42	56,5	30,36	71		E	1	Cloudy.
	2	0	44	56,5	30,35	67		NE	1	Cloudy.
30	7	0	42	55	30,36	75		NE	1	Cloudy.
	2	0	44	56	30,36	71		NE	1	Cloudy.

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1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Dec. 1	8	0	42	52,5	30,38	76	0,035	E	1	Cloudy.
	2	0	44	56	30,35	74		NE	1	Cloudy.
2	8	0	42	55	30,26	75	0,043	NE	1	Cloudy.
	2	0	44	55	30,19	70		NE	2	Cloudy.
3	8	0	39	54	30,19	75		NE	1	Cloudy.
	2	0	41	54	30,26	65		E	1	Cloudy.
4	8	0	32	53	30,29	63		WSW	1	Cloudy.
	2	0	38	54	30,25	60		SW	1	Cloudy.
5	8	0	32	52	30,28	75		WSW	1	Cloudy.
	2	0	40	52	30,32	75		WNW	1	Cloudy.
6	8	0	38	52	30,30	74		SW	1	Cloudy.
	2	0	43	53,5	30,22	72		WNW	1	Cloudy.
7	8	0	31	51	30,09	73		WNW	1	Fair.
	2	0	38	53	29,99	71		SW	1	Foggy.
8	8	0	39	51	29,90	73		SW	1	Cloudy.
	2	0	44	53,5	29,87	71		SW	1	Cloudy.
9	8	0	42	51	29,77	76		SSW	1	Cloudy.
	2	0	45	53	29,67	70		SSW	1	Cloudy.
10	8	0	43	52	29,51	74		E	1	Cloudy.
	2	0	50	55,5	29,38	70		SE	1	Fine.
11	8	0	47	52,5	28,72	*		ESE	2	Rain.
	2	0	53	56	28,77			SW	2	Cloudy.
12	8	0	50	55	29,15		0,130	SW	1	Cloudy.
	2	0	53	57	29,28			SSW	1	Cloudy.
13	8	0	54	57	29,20		0,140	S	2	Rain.
	2	0	53	60	29,28			S	2	Fair.
14	8	0	48	57	29,47		0,060	S	2	Cloudy.
	2	0	53	59	29,41			SE	2	Cloudy.
15	8	0	45	57,5	29,48			SSW	1	Cloudy.
	2	0	50	58,5	29,50			SSW	1	Cloudy.
16	8	0	50	57	29,15		0,704	SW	1	Rain.
	2	0	49	58,5	29,30			NW	1	Cloudy.

* This interruption, in the observations of the hygrometer, was occasioned by one end of the whalebone having slipped out of the pincers by which it is held.

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for December, 1793.

1793	Time. H.	Time. M.	Therm. without. °	Therm. within. °	Barom. Inches.	Hygrometer.	Rain. Inches.	Winds. Points.	Winds. Str.	Weather.
Dec. 17	8	0	39	56	29,84		0,158	SW	1	Fine.
	2	0	48	58	29,79			S	2	Rain.
18	8	0	51	56,5	29,56		0,251	SSW	2	Cloudy.
	2	0	51,5	59,5	29,48			SSW	2	Cloudy.
19	8	0	43	57	29,44		0,160	S	2	Fine.
	2	0	51	59	29,49			S	2	Fine.
20	8	0	37	57	29,58			SSE	1	Cloudy.
	2	0	40	58	29,57				1	Foggy.
21	8	0	38	56	29,49			SE	1	Fine.
	2	0	44	57,5	29,29			SE	2	Cloudy.
22	8	0	42	55	28,97		0,074	E	1	Cloudy.
	2	0	47	57	28,99			ESE	2	Cloudy.
23	8	0	44	55,5	29,28		0,054	E	1	Cloudy.
	2	0	49	59	29,44			E	1	Cloudy.
24	8	0	43	55,5	29,72			NE	1	Cloudy.
	2	0	46	58	29,78			NE	1	Cloudy.
25	8	0	42	55	29,96			NE	1	Cloudy.
	2	0	43	56,5	29,98			NE	1	Cloudy.
26	8	0	41	55	30,11			E	1	Cloudy.
	2	0	41	56	30,10			E	1	Cloudy.
27	8	0	38	54	30,03			E	1	Cloudy.
	2	0	40	56	29,98			E	1	Cloudy.
28	8	0	37	53	29,94			NE	1	Cloudy.
	2	0	39	54	29,89			NE	1	Cloudy.
29	8	0	36	52	30,05			NNE	1	Cloudy.
	2	0	39	54	30,11			NNE	1	Fine.
30	8	0	30	50	30,14			E	1	Cloudy.
	2	0	32	52	30,09			ESE	1	Foggy.
31	8	0	38	50	29,80			S	2	Cloudy.
	2	0	39	54	29,74			SE	2	Fair.

1793.	Thermometer without.			Thermometer within.			Barometer.			Hygrometer.			Rain.
	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	
	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Inches.	Inches.	Inches.				Inches.
January	48	28	37,6	54	45	49,6	30,52	28,98	30,16				1,565
February	52	30	42	57	49,5	52,5	30,22	29,29	29,80				1,581
March	52	33	41,5	58	49,5	54	30,21	29,07	29,84	83	51	64	1,162
April	60	33	45,5	59,5	50	55	30,27	29,22	29,89	85	46	61,3	1,095
May	69	44	54,4	64	56	59,2	30,29	29,24	30,04	70	43	57,4	0,865
June	72	47	59,1	63	57	60,6	30,20	29,68	29,96	72	46	56,3	0,427
July	89	54	68	76	62	69	30,30	29,74	30,03	74	43	55,4	1,616
August	80	52	63,7	70,5	63,5	66,3	30,28	29,34	29,95	73	47	58,4	1,315
September	66,5	42	55,4	66	56	61,2	30,45	29,41	29,98	82	50	66	2,452
October	65	35,5	54,3	64	56	60,6	30,48	29,22	29,98	84	57	68,5	1,137
November	56	31	45,5	61	53	56,4	30,36	29,05	29,80	83	64	72,2	2,104
December	53	30	42,9	60	50	55,1	30,38	28,72	29,74				1,809
Whole year			50,8			58,3			29,93				17,128

PHILOSOPHICAL

TRANSACTIONS,

OF THE

ROYAL SOCIETY

OF

LONDON.

FOR THE YEAR MDCCXCIV.

PART II.

LONDON,

SOLD BY PETER ELMSLY,

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Jos: Banks

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ERRATA.

Page 190 line 2 from bottom, note, *for* description, *read Description.*
Page 192 line 2 from bottom, note, *dele L.* after *Indicar.*
Ibid. line last, *for* STATIUS, *read* TATIUS.

N. B. The pagination of sheet I i is wrong throughout in the hundreds; 141 being put for 241, and so on.

PHILOSOPHICAL

TRANSACTIONS.

XII. *On the Conversion of Animal Muscle into a Substance much resembling Spermaceti.* *By* George Smith Gibbes, *B. A. of Magdalen College*, Oxford. *Communicated by* George Shaw, *M. D. F. R. S.*

Read March 13, 1794.

It is a matter of great curiosity to observe, after any fact has been well ascertained, how many things might have led to a much earlier investigation; particularly so, had the writings of many great men been equally examined, with those observations which, though apparently very trifling, have often excited general attention. The conversion of animal muscle into a fatty matter gives us a very striking example.

The celebrated Sir Thomas Brown, in his very learned and curious treatise intituled *Hydriotaphia*, assures us, that he has found a soap-like substance in an hydropical body. His words are as follow, viz. "In an hydropical body, ten years buried in "a church-yard, we met with a fat concretion, where the nitre

" of the earth, and the salt and lixivious liquor of the body,
" had coagulated large lumps of fat into the consistence of
" the hardest Castile soap; whereof part remaineth with us."

Lord BACON, in his work intituled *Sylva Sylvarum*, also mentions this curious circumstance: " You may turn (almost)
" all flesh into a fatty substance; if you take flesh and cut it
" into pieces, and put the pieces into a glass covered with
" parchment; and so let the glass stand six or seven hours in
" boiling water. It may be an experiment of profit for mak-
" ing grease or fat for many uses; but then it must be of such
" flesh as is not edible, as horses, dogs, bears, foxes, badgers,
" &c."

Animal muscle, having lost its living principle, has been generally supposed to undergo, when exposed either to the action of air or water, that kind of decomposition only which is known by the name of the putrefactive fermentation. Since the discovery of the bodies in the *Cimetière des Innocens* at Paris, this subject has been more attended to; and a substance much resembling spermaceti, is now known to be formed by combinations which take the animal flesh and water.

If you put flesh under water, and let it stay some time, it will get very offensive, and the putrefactive fermentation will in some measure most assuredly take place. This seems to have been the reason why the substance remaining in the water had not been more accurately examined, it being imagined that as this decomposition had commenced, the whole would be changed in the same manner. It would appear strange, if the same substance, exposed to the action of two such different bodies as air and water, should undergo precisely the same change. That they do not, has been lately proved by many

experiments, and that the putrefactive fermentation is not at all necessary in the formation of this fatty matter, I think some of the following experiments will shew.

After having seen some of the matter found in the *Cimetière des Innocens* at Paris, I concluded that in some situations the same kind of substance might be easily found; accordingly I examined some of the macerating tubs belonging to anatomical schools in town, and I found that in most of them the flesh was nearly changed into this kind of fat. By the indulgence of Dr. PEGGE, the anatomical professor in Oxford, I was permitted to examine the receptacle in which the bodies are deposited, after he has finished lecturing on them. This place is a hole dug in the ground to the depth of about 13 or 14 feet, and, to remove all offensive smell, a little stream is turned through it. I found, on first looking into it, that the flesh was quite white, and on drawing up the first piece, I found it changed in the manner before described. From this place I have procured at least 12 pound weight of a substance equal in every respect to spermaceti.

Having seen many specimens of different animals, which had been changed under somewhat different circumstances, that is, where some had been buried in dampish ground, some in wet ground, and some even in water itself, I began to suspect that I might bring about the same change in a shorter time, at least I might determine the time necessary for it: with this view a piece of the leanest part of a rump of beef was confined in a box full of holes, which being tied to a tree near a river, was suffered to float in it. On taking this up from time to time, I perceived that it gradually got whiter and whiter, and at the

end of a month it was perfectly to appearance changed to a mass of fatty matter. From some circumstances, I am induced to believe that it is sooner converted in running water than when it is perfectly at rest; for when this beef was exposed to the water in the river, a piece of mutton was placed in a reservoir of water, and I perceived, that though the mutton was exposed for a longer time than the beef, yet it was not so much changed.

Finding that this substance was so formed, and that I could procure large quantities of it, I tried some experiments to purify it; for this purpose I took several pieces of it and melted them, and I found, though they were brought into a closer union, yet the fœtid smell was as bad as before. After trying some unsuccessful experiments, it occurred to me that if I could add a substance to it which would unite with the offensive parts, and not with the fat, I might then get it pure; accordingly I poured some nitrous acid upon it, which immediately had the desired effect; a waxy smell was perceived, and on separating and melting it, I got it nearly pure. The nitrous acid turns it yellow, but by submitting it to the action of the oxygenated muriatic acid, I have got it quite white and pure. In the beginning of last June I buried a cow, in a place where, from the rising of a river to supply a mill twice a day, it was submitted to the action of running water. On taking this cow up in December, I found that where the water was constantly running over it, there it was changed into a fatty substance, but where the water which had acted on the meat could not pass off, there a very disagreeable smell was sensible, and the flesh was not so much changed. A piece of this cow, that was perfectly

lean, was stuck through with a stick, and fastened to the bottom of the river; this piece was perfectly changed into a fat matter, and had lost its offensive smell.

I have brought about this change in a much shorter time, in the following manner. I took three lean pieces of mutton and poured on them the three mineral acids, and I perceived that at the end of three days each was much altered; that in the nitrous acid was much softened, and on separating the acid from it, I found it to be exactly the same with that which I had before got from the water; that in the muriatic acid was not in that time so much altered; the vitriolic acid had turned the other black.

From these experiments, it appears to me that it is not at all necessary that the putrefactive fermentation should take place; on the contrary, that it takes away a great deal of the flesh which might serve for the formation of a greater quantity of this waxy substance.

The foregoing experiments may not appear new to every one, but as they are perfectly so to me, I take the liberty of offering them.

XIII. *Abstract of a Register of the Barometer, Thermometer, and Rain, at* Lyndon, *in* Rutland, 1793. *By* Thomas Barker, *Esq. Communicated by Sir* Joseph Banks, *Bart. P.R.S.*

Read March 27, 1794.

		Barometer.			Thermometer.						Rain.
					In the House.			Abroad.			
		Highest.	Lowest.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	Lyndon.
		Inches.	Inches.	Inches.	°	°	°	°	°	°	Inches.
Jan.	Morn.	30,02	28,50	29,56	43	33	37½	42	25½	35	1,913
	Aftern.				43½	34	38	46½	32½	38	
Feb.	Morn.	29,70	28,73	27	48	38	41½	51	29	37	1,073
	Aftern.				51½	39½	42½	52	38	44	
Mar.	Morn.	29,80	28,59	38	45	37	41½	44½	30	36	2,773
	Aftern.				46	37½	43	55	38	44½	
Apr.	Morn.	29,85	28,72	43	49	39	44	46	31	38	3,002
	Aftern.				51	41	45	60	35½	48	
May	Morn.	29,85	28,70	58	57	48	52	57½	41	48	0,452
	Aftern.				60	49	53	69	49½	58½	
June	Morn.	29,78	29,19	49	61	50	56	59½	48	54	0,423
	Aftern.				63	53	58	76½	55	66	
July	Morn.	29,80	29,21	58	71½	59	64	69	54	61½	0,776
	Aftern.				79½	60	67	89	64	75	
Aug.	Morn.	29,81	28,73	47	66½	57½	61	62	48½	56	2,609
	Aftern.				70	58	63	80	59	69	
Sep.	Morn.	29,96	28,90	51	60	50	55	58	41	49½	3,848
	Aftern.				61½	51	56½	71	47½	60½	
Oct.	Morn.	29,98	28,76	49	59½	45½	54	58	32	49½	1,266
	Aftern.				62½	46	55½	67	40	58	
Nov.	Morn.	29,91	28,61	34	50	43	46	48½	28	41	3,427
	Aftern.				51	43	46½	52½	40	45½	
Dec.	Morn.	29,91	28,26	26	50	36	43½	52½	26½	39½	1,351
	Aftern.				52	37	43½	53	31	42½	
July 5 to 18		29,80	29,27	29,62	71½	63	65	68½	61	64½	22,913
					79½	66	71	89	72½	80	

The winter was in general an open one; about a week's frost at the beginning of the year, the rains less than they had been, yet at times enough to keep it very dirty. The latter end of January, and the month of February were mild and fine, and the birds singing, but it was windy at times, and more so in March, which was a very uncertain month, being alternately windy, fine, wet, and at the end frosty; and the first of April there came a great snow, the only considerable one this winter, and was followed by floods for several days together, and a very backening season. This great snow and wet coming after a good deal of the spring corn was sown, was a damage to the crops; and the three following months being very dry, and just in the long days, the ground cracked and burnt very much, and many of the spring crops were very small, both for hay, straw, and corn; the wheat crop was the best, and that was pretty good.

The former part of the summer was cool, and sometimes cold, frequent frosty mornings, even into June; but July was hot and burning, and the fortnight from July 5 to 18 was uncommonly so; nine days out of twelve the thermometer was up to or above 80, and one day it was 89; this I think I never knew before, either for height or continuance, unless it was so in that hottest of summers 1750. This hot dry time hindered the sowing or coming up of turnips, which were late and dear this year. The hay, except on some moist meadows, was very light, but well gotten, as was also all the grain, but very dear, especially the spring corn.

This summer was complained of as dry, but it was so only the three months May, June, and July; there was only the quantity of one month's rain in those three months, and that

being just in the long days, in the high strong sun, and when all the crops should be in their greatest growth, they were much hurt by it, and perhaps the more so for having been before oversoaked with snow and wet. The latter part of the summer was very fine, rain enough to make the grass grow, and fine enough to get the crops in well; great eddishes, and more grass than there had been in any part of the summer before. And when in September and November there came two wet months, the cracks and dryness of the ground underneath carried it all clear off. The autumn also was remarkably fine, calm, mild, and almost without frost, so that the grass continued green till Christmas, which was very useful to the farmers, as it saved their fodder very much, which was very scarce.

XIV. *Observations on some* Egyptian *Mummies opened in* London. *By* John Frederick Blumenbach, *M.D. F.R.S. Addressed to Sir* Joseph Banks, *Bart. P.R.S.*

Read April 10, 1794.

AMONG the many instances of kindness I have experienced during my late abode in London, of which the recollection can never be obliterated from my memory, I reckon and acknowledge with gratitude, the uncommon, and to me very interesting, opportunities that were afforded me, to open and examine several Egyptian mummies.

A few days after my arrival, I found in the library of my honoured friend Dr. GARTHSHORE, F. R. S. among other Egyptian antiquities, a small mummy, not above one foot in length, of the usual form of a swathed puppet, wrapped up in cotton bandages, painted and gilt in its front part, and inserted in a small sarcophagus of sycamore wood, in which it fitted exactly.

Having expressed a wish to know the contents of this figure, the Doctor was kindly pleased to permit the opening of it; which accordingly took place on the 21st of January, 1792, at his house, in the presence of the President and several members of the Royal Society, and other men of letters.

The mummy itself measured $9\frac{1}{2}$ inches in length, and 8 inches in circumference at the breast, where it was of the greatest thickness.

The mask, exhibiting human features, was of a gypseous plaster, which here and there shewed some signs of having once been gilt.

Of the semicircular breast-plate, only some fragments were still extant.

The lower part of the front covering was, as is frequently observed on large mummies, in a manner dissected in regular compartments; and on it were painted the two standing figures that so often appear on the integuments of mummies, viz. on the right side, Anubis with the dog's head, and on the left, Osiris with the head of a sparrow-hawk.

The mummy itself was opened at the side. The outward integuments were glued so fast upon each other that it was found necessary to use a saw: the inner ones were less adhesive. I counted in the whole above 20 circumvolutions of these cotton bandages.

Within these was found, as a kind of nucleus, a bundle, about 8 inches long, and full 2 inches in circumference, of the integuments of a *larger* mummy, strongly impregnated with a resinous substance, which rendered it hard and compact, and which appeared on the edge to have been shaped into this oblong form by the paring of a knife. Pieces of this mass having been put on a heated poker, emitted a smell perfectly similar to that of fir-rosin, or the drug called *wild incense* from ant-hills.

The sarcophagus consisted of six small square boards of sycamore, fastened together with iron nails.

Soon after, I found in the collection of Dr. LETTSOM, F. R. S. another similar mummy, which, outwardly, perfectly resembled the above, was likewise contained in a sarcophagus, and differed

only in the dimensions, this being $14\frac{1}{2}$ inches long, and $11\frac{1}{2}$ in circumference at the breast.

The proprietor was likewise kind enough to suffer me to open it, which I did at his house on the 29th of January.

But much as it resembled Dr. GARTHSHORE's mummy externally, it was found very different as to its contents, there being in it a great number of detached bones of the skeleton of an *Ibis*, which were only here and there indued with rosin.

This striking difference, no doubt, rather excited than satisfied my curiosity; and having hereupon found in the British Museum no less than three such diminutive mummies, which were now to me become enigmatical, (viz. two in the HAMILTONIAN collection of antiquities, both contained in the same kind of square wooden coffins, clinched with iron nails, and the third in the SLOANIAN collection), I felt an irresistible impulse to apply to the President of the Royal Society, as one of the curators of the Museum, for his interference towards obtaining permission to open one of these three, in order to have an opportunity for some further comparison.

The result of this application was, that at the very next meeting of the curators leave was granted me, in the most liberal manner, not only to open one of these little mummies, but also to choose among the four large ones that are in that noble repository, the one that should appear to me the most likely to afford some material information on the subject.

I chose among the small ones the SLOANIAN, as it seemed to me to differ more than the two in the HAMILTONIAN collection, from either that of Dr. GARTHSHORE or Dr. LETTSOM. The four large mummies resembled in the main the one deposited in the academical museum of Gottingen, which I

examined in the summer of the year 1781. I selected, however, the one that appeared to differ most from the others, and from ours, by the very close adhesion of the bandages, from which I had reason to expect some difference in the interior preparation of it.

The 18th February was appointed for the opening of these two mummies at the Museum, in the presence of a numerous and respectable meeting.

The small mummy was externally very similar to those I had opened before, except that it was only $11\frac{6}{10}$ inches in length, and $8\frac{2}{10}$ inches round the breast, somewhat more compact in the handling, and, proportionably to its size, rather heavier.

On sawing it open, a resinous smell was immediately emitted, and glutinous particles of rosin adhered to the heated saw. This was owing to the cotton bandages having been from without impregnated with rosin, which was not the case with the two former ones.

On opening it completely, we found in the inside a human *os humeri,* being part of the mummy of a young person, perhaps eight years old, who had been embalmed with rosin; and with it were also found some shreds of the original integuments likewise impregnated with rosin. The upper end (*caput*) of the bone was inserted in the head, and the lower extremity was at the feet of the little figure.

Although when viewed externally nothing appeared suspicious in this little mummy, I found, however, on examining carefully the successive integuments, that the outward ones had some traces of our common *lint paper*, with which it seemed to have been *restored*, and afterwards painted over.

The large mummy I was permitted to examine, appeared by its stature to be that of a young person, not above 14 years old, but who had not, it seemed, as yet shed all his teeth. Its outward painted integuments were very similar to those of the Gottingen mummy, as it is figured in the IVth. Vol. of the *Commentationes Societatis Scientiarum*. The bandages about the head were in a manner caked together by means of rosin. The skull was inclosed in a kind of cast of the same substance, which could with difficulty be removed from it. It seemed also, to judge by its weight, to be filled with rosin, which particularly appeared in the cavity between the palate and the lower jaw. The rosin here having been gradually punched out, not the least appearance of a tongue was discernible; though some have asserted to have found traces of it in mummies; nor was any thing like the little golden plate (the supposed *naulus*) to be here met with. There were no remains whatever of the soft fleshy parts, of skin, tendons, &c.; in short, nothing was found but mere naked bones.

The *maxillæ* were sensibly prominent, but by no means so much as in a *true Guinea face*; and not more so than is often seen on handsome negroes, and not seldom on European countenances.

What appeared to me very remarkable, and has, as far as I can learn, never yet been noticed, is two exterior artificial ears, made of cotton cloth and rosin, and applied one on each side of the head. That on the right side was prominent; but the other seemed to have been shoved from its proper place; it was compressed, and much disfigured.

The cotton bandages on the remainder of the body were loose, not glued together, and readily yielded to the pressure of the hand.

The great cavity of the trunk was filled with bundled rags, and dark brown vegetable mould, in which, however, some pieces of rosin were here and there discovered. But the inside of the thoracic cavity on both sides of the spine, and the inner surface of the *ossa ilium*, were covered with a thick coat of rosin.

No idol, or any artificial symbol whatever, was found in the inside of this mummy. Nor did it contain any thing like an onion, such as have been now and then found about the parts of generation, or under one of the foot-soles of mummies.

The bones of the arms lay along the side of the body, in the same manner as those of the Gottingen mummy, and the one at Leipzig, described by KETTNER. Whereas in the mummy at Gotha, described by HERTZOG, the two at Breslau, that were examined by GRYPHIUS, another at Copenhagen, that was dissected by BRÜNNICH, and a fifth which belonged to the Royal Society, and has been described by Dr. HADLEY in the Philosophical Transactions, the arms were found lying across over the breast.

On some of the bones of the arms, for instance on the left *os humeri*, was found some glutinous rosin, which on being touched stained the fingers of a dusky red greasy colour, and had a strong empyreumatic alkaline taste. In the remainder of the body, the dry rosin was almost entirely covered or impregnated with a saline crust, by which the *thoracic vertebræ* in particular were much corroded, and which had entirely stripped the intermediate *corpora vertebrarum* of their *periosteum*.

Circumstances did not allow me to make any experiments on this salt; but I have since obtained from my worthy friend

JOHN HAWKINS, Esq. F. R. S. some considerable pieces of mummies which he had bought of a druggist at Constantinople, one of which was covered and impregnated with a saline incrustation, which in taste and appearance was very similar to that I have just now mentioned. Of this I dissolved a part in water, filtered and evaporated the solution, and thus obtained a true *soda*, or mineral alkali *(natrum)*, which shot into very neat and regular crystals. (See Tab. XVI. fig. 4.)

For the sake of comparison, I examined another large mummy in the Museum, which had already been opened in several places. This was of a full grown person, and measured 5 feet 5 inches in length. Like the former, it shewed not the least trace of any of the soft parts, but consisted of nothing but naked bones.

Except a little rosin which stuck fast between the teeth, this mummy, as far as its inside could be examined, contained none of that substance; its thoracic and abdominal cavities being entirely filled with a dark brown mould, which also occupied the whole space between the palate and the lower jaw, where it could easily be loosened and drawn out with the fingers.

The *maxillæ* of this mummy were still less prominent than those of the former one.

Some weeks after, viz. the 17th March, I had an opportunity to examine one more mummy at the Honourable CHARLES GREVILLE'S, F. R. S. which had four years before, viz. March 29, 1788, been already opened in the presence of several curious spectators. It belonged to JOHN SYMMONS, Esq. of Grosvenor house, Westminster, who with the most obliging readiness allowed me unconditionally, not only to dissect it as

much more as I should think proper, but also to select and take away whatever parts of it I should think worthy of a particular investigation.

It was a mummy of a child about six years old, which as to its preparation, (viz. without rosin, and without the least remaining trace of any of the soft parts), and the painted semicircular breast-plate, consisting of several folds of cotton cloth glued upon each other, was very similar to those at the British Museum, and the one at Gottingen, except that the characters upon that part of the cotton integument which covered the shanks, resembled rather more the figures of the one delineated by Count CAYLUS, in his *Recueil, &c.* Vol. V. Tab. XXVI—XXIX.

Nothing remained of the head but some pieces of the bones of the face, a few teeth, and the mask, which still adhered to the cotton bandages.

Among the teeth I found the *incisores*, which notwithstanding the tender age of the person had however a very short thick crown, considerably worn away at that edge which is usually sharp. This, therefore, is a new confirmation of the extraordinary phænomenon which I had already noticed in a complete skull, and some fragments of jaws, in my own collection,* and which had also been observed by MIDDLETON in the Cambridge mummy,† and by BRÜCKMANN in the one that is at Cassel.‡ STORR has also seen something similar in a mummy that is preserved at Stuttgard.§

* *Decas Craniorum*, I. Tab. I.

† MIDDLETON'S Miscellaneous Works, Vol. IV. p. 170.

‡ BRUCKMANN'S Account of this Mummy. Brunswick, 1782, 4to.

§ STORR, *Prodromus Methodi Mammalium*. Tubing. 1780, 4to. p. 24.

If we reflect during how many centuries, and through what a variety of revolutions, the Egyptians have used the practice of mummifying their dead bodies, it will naturally occur that we are not to expect in all mummies a similar characteristic formation of the teeth, any more than we are to look for a similar characteristic national form in their productions of art.

This peculiar structure of the teeth was not observed in the two mummies I examined in the British Museum, neither does it exist in our Gottingen mummy. A detached skull of a mummy in the Museum, prepared with rosin, and which bore great resemblance to the abovementioned in its general form, and especially in the narrowness of the poll, had unfortunately the crowns of the teeth so much mutilated as to afford no manner of information concerning this circumstance.

The above observation however appears, at all events, to be well worth attending to, as it may hereafter prove a criterion for determining the period at which any given mummy has been prepared.

But what interested me most in Mr. SYMMONS's mummy was the *mask*, to the two sides of which pieces of the bandages, with which the whole of the exterior integuments had been fastened to the corpse, still adhered. The inner part of this mask was sycamore wood, its outside being shaped, by means of a thick coat of plaster, in bas-relief, into the form of a face, the surface of which seemed to have been stained with natural colours, which time had now considerably blended and obscured. Having, however, with Mr. SYMMONS's leave, taken this mask, together with some other very interesting pieces of his mummy, with me to Gottingen, I there steeped it in warm water, and carefully separated all the parts of it. By this means

I discovered the various *fraudulent artifices* that had been practised in the construction of this mask: the wooden part was evidently a piece of the front of the sarcophagus of the mummy of a young person; and in order to convert its alto-relievo into the basso-relievo of the usual cotton mask of a mummy, plaster had been applied on each side of the nose; after which paper had been ingeniously pasted over the whole face, and lastly, this paper had been stained with the colours generally observed on mummies.

The small SLOANIAN mummy in the Museum had probably been prepared nearly in the same manner. That the deception has in both cases been very industriously executed, appears from this, that, as far as I can learn, no one has observed it before, although both these pieces have no doubt been often seen, and examined by persons conversant with these matters.

Some other suspicious circumstances in the mummies I examined in London were more evident. For instance, the coffins of sycamore wood fastened together with *iron* nails, in which the small mummies of Dr. GARTHSHORE, Dr. LETTSOM, and Sir W. HAMILTON, were contained, had most probably been recently constructed of pieces of decayed sarcophagi of ancient mummies. The little SLOANIAN mummy even lay in a box in the form of a sarcophagus, which was made of a dark-brown hard wood, totally different from the sycamore, and manifestly of modern construction.

How many other artificial restorations and deceptions may have been practised in the several mummies which have been brought into Europe, which have never been suspected, and may perhaps never be detected, may well be admitted, when we consider how imperfect we are as yet in our knowledge of

this branch of Egyptian archæology, which, as a specific problem, few have hitherto treated with the critical acumen it seems to deserve.

All the knowledge we have concerning the manner of preparing mummies is derived from two sources, viz. (*a*) the examination of the mummies themselves; and (*b*) two classical passages in HERODOTUS and DIODORUS SICULUS; STRABO and other ancient authors having mentioned mummies only incidentally, and in very few words.

But unfortunately these two classical passages do not in the least agree with the state of the mummies brought into Europe, which are in general of two sorts, viz. (*a*) the hard compact ones, wholly indued with rosin, which hence can be *knocked into pieces*; (*b*) the soft ones, which yield to the pressure of the hand, and are prepared with very little rosin, and often none at all, *whose loose bandages may be wound off*, and which contain in their cavities scarce any thing but a vegetable mould, and particularly no idol whatever as far as I have been able to learn.

The front part of the latter is usually covered with a painted, and, at times, gilt mask of cotton cloth; and as they appear more variegated than the former, and have no rosin in them yielding drugs for traffic, they are brought in much greater numbers, and may be seen in many collections in Europe in a more perfect state than the former, though often rendered so by restoration. The former, on the contrary, have for this very reason remained most of them in the hands of druggists.

Of this, viz. the former sort, were the two in the dispensary of CRUSIUS at Breslau, which GRYPHIUS described in the year

1662, and particularly the very valuable body of a mummy which was opened by the apothecary HERTZOG, at Gotha, in 1715, and in which more idols, beetles, frogs (as symbols of fertility), nilometers, &c. were found, than was ever, to the best of my knowledge, known to have been contained in any other mummy whatever.

But HERODOTUS, that very *inquisitive and credulous historian* (as one of the most learned and judicious antiquaries in England has named him), does not so much as mention either of these sorts of mummies; nor does he speak of the rosin, or painted masks, although he expressly describes such painted integuments on the Æthiopian mummies.

DIODORUS is equally silent as to the rosin, and the painted covering; whilst on the other hand he advances some very strange assertions, such as that the skill of the embalmers extended so far as perfectly to preserve the lineaments of the face, although the faces of mummies of both sorts be generally covered with cotton cloth to the thickness of nearly a man's hand.*

These authors, although they have both been in Egypt, had probably their intelligence merely from hearsay; for, on the other hand, it would no doubt be too paradoxical to assert, that all the mummies we are now acquainted with have been made since the days of DIODORUS, and that none of those described by him and by HERODOTUS should have reached our time. Count CAYLUS rather conjectures, that no mummies were made since the conquest of Egypt by the Romans (about the time of DIODORUS); but in this he is manifestly mistaken, since we learn from St. AUGUSTIN that so low down

* This had already been noticed by MIDDLETON, *l. c.*

as his own times (viz. in the first half of the fifth century) mummies were certainly made in Egypt.* But that among the mummies that now exist, especially the hard ones, which are entirely done over with rosin, there cannot but be many of a much greater antiquity, will, among other proofs, appear particularly from the style of workmanship of several of the little idols contained in them.

At least it may be admitted, without much hesitation, that the mummies we now possess, which differ so much in their preparation and characteristic structure, are at least of a period including one thousand years.

But it were much to be wished that we might have *certain criteria, to determine with some accuracy* the precise age of any particular mummy that may happen to fall into our hands. Before, however, we can expect to obtain this object, the two following *pia desideria* must first be accomplished, viz.

(A) A more accurate determination of the *various*, so strikingly *different*, and yet as strikingly *characteristic* national configurations in the monuments of the Egyptian arts, together with a determination of the periods in which those monuments were produced, and the causes of their remarkable differences.

(B) A very careful technical examination of the characteristic forms of the several *skulls* of mummies we have hitherto met with, together with an accurate comparison of those skulls with the monuments abovementioned.

This, at least, I consider as the surest method of solving the problem; being persuaded that, especially after what has just now been said of the fraudulent restorations, it can hardly be

* Augustt. Serm. 361. (Oper. T. V. p. 981.)

expected that we should be able to draw any just inferences from the mere style, and the contents of the painted integuments of the mummies we may have opportunities to examine.

Still less can we infer aught from the sculpture or paintings on the sarcophagi, as to the contents of the mummies sent us into Europe; MAILLET having about sixty or seventy years ago detected the fraud of the Arabs, who he says are in the practice of breaking in pieces the mummies contained in the catacombs in the more ornamented sarcophagi, for the sake of the idols they expect to find in them, of replacing them with tolerably preserved common painted mummies (such as I have called soft), and thus offering them for sale.

The osteological properties which I have had opportunities to observe in the skulls of mummies, are most of them mentioned in the description of my collection of the skulls of different nations above quoted; and will, I hope, prove useful to others for further comparisons.

As to the *different* national physiognomies of the ancient Egyptians, I shall here advert only to what, in my physiological study of the varieties in the human species, I have deduced from my comparisons of these skulls with the artificial monuments found in Egypt. For I am wholly at a loss to conceive how learned writers, not only of the stamp of the author of the *Recherches sur les Egyptiens*;* but even professional antiquaries, such as WINKELMANN,† and the author of the *Recherches sur l'Origine des Arts de la Grèce*‡ could ascribe to the artificial monuments found in Egypt *one common* cha-

* T. I. p. 237.

† In his description *des Pierres gravées de Stosch.* p. 10, and in other works of his.

‡ T. I. p. 300.

racter of national physiognomy, and define the same in a few lines in the most decided and peremptory manner.

It appears to me that we must adopt at least *three* principal varieties in the national physiognomy of the ancient Egyptians; which, like all the varieties in the human species, are no doubt often blended together, so as to produce various shades, but from which the *true*, if I may so call it, *ideal* archetype may however be distinguished, by unequivocal properties, to which the endless smaller deviations in individuals may, without any forced construction, be ultimately reduced.

These appear to me to be, 1. the Æthiopian cast; 2. the one approaching to the Hindoo; and, 3. the *mixed*, partaking in a manner of both the former.

The first is chiefly distinguished by the prominent *maxillæ*, turgid lips, broad flat nose, and protruding eye-balls, such as Volney finds the *Copts* at present;* such, according to his description, and the best figures given by Norden, is the countenance of the Sphinx; such were, according to the well-known passage in Herodotus on the origin of the Colchians, even the Egyptians of his time; and thus hath Lucian likewise represented a young Egyptian at Rome.† (See Tab. XVI. fig. 1.)

The second, or the *Hindoo cast*, differs *toto cælo* from the above, as we may convince ourselves by the inspection of other Egyptian monuments. It is characterized by a long slender nose, long and thin eyelids, which run upwards from the top of the nose towards the temples, ears placed high on the head,‡

* Both in his *Voyage en Syrie*, &c. T. I. p. 74; and the *Ruines, ou Méditations sur les Révolutions*, p. 336.

† *Navigium s. Vota*, c. 2. (Oper. T. III. p. 248.)

‡ The author of the *Recherches sur les Egyptiens* is pleased to consider this as a

a short and very thin bodily structure,* and very long shanks. As an *ideal* of this form, I shall only adduce the painted female figure upon the back of the sarcophagus of Capt. LETHIEULLIER's mummy in the British Museum, which has been engraved by VERTUE, and which most strikingly agrees with the unequivocal national form of the Hindoos, which, especially in England, is so often to be seen upon Indian paintings. (See fig. 2.)

The third sort of Egyptian configuration is not similar to either of the preceding ones, but seems to partake something of both, which must have been owing to the modifications produced by local circumstances in a foreign climate. This is characterized by a peculiar turgid habit, flabby cheeks, a short chin, large prominent eyes, and rather a plump make in the person.† This, as may naturally be expected, is the structure most frequently to be met with. (See fig. 3.)

I thought this little digression the less intrusive, as it appears to me that it may on the one hand prove useful, not only towards illustrating the history of the origin and descent of the nations that were transplanted into Egypt, and have acquired the general denomination of Egyptians, but also for the determination of the different periods of the *style of the arts of the ancient Egyptians*, concerning which we have as yet very imperfect ideas; whilst, on *the other hand*, it might lead to much accurate information as to matter of fact, many very eminent authors having given the most *incongruous* representations of the Egyptian national character, such as WINKELMANN for

mere defect in the drawing; no doubt an excellent expedient this, to get rid of difficulties in the investigation of national varieties.

* Compare with this ARRIAN's representation of the Indians, *Rer. Indicar. L.* p. 542.

† Compare ACHILLES STATIUS *Erotic.* L. iii. p. 177.

instance, who produced a wretched figure of a painted mask, without any character whatever, engraved in BEGER's *Thesaur. Brandenb.* T. III. p. 402, as one of the most characteristic representations of the form of the ancient Egyptians; and who, as well as several others, will have this form to be similar to that of the Chinese; an assertion which, after having had opportunities to compare twenty-one living Chinese at Amsterdam, and having since seen in London abundance of ancient Egyptian monuments, especially in the British Museum, and the collections of Mr. TOWNLEY, Mr. KNIGHT, and the Marquis of LANDSDOWN, has ever appeared to me incomprehensible.

Adopting, as I think it conformable to nature, five races of the human species, viz. 1. the Caucasian; 2. the Mongolian; 3. the Malay; 4. the Ethiopian; 5. the American; I think the Egyptians will find their place between the Caucasian and the Ethiopian, but that they differ from none more than from the Mongolian, to which the Chinese belong.

Thus far concerning the bodies of the Egyptians prepared into mummies. I shall conclude with some observations on the probable meaning and destination of the diminutive mummies, which have given rise to the present inquiry.

They certainly are *not* what they have long, I believe, universally been taken for,* namely, mummies of small children and embryos. Some of them are the real mummies of Ibises, such as the one of Dr. LETTSOM, and one of the two in the HAMILTONIAN collection, in the British Museum, which had by decay been so far laid open as to allow me plainly to distinguish in it the bill of an Ibis, and other bones of a bird.

* See, for example, M. THR. BRÜNNICH's *Dyrenes Historie og Dyre-Samlingen, udi Universitetets Natur-Theater.* T. I. p. 2.

These sacred birds, it is well known, were usually, after having been swathed round with cotton bandages, placed in earthen urns, and deposited in the catacombs appropriated to the Ibises. Sometimes, without being stuck into an urn, they were prepared in the form of a puppet, yet so that the head and bill projected at the top; one of this sort has been figured by Count CAYLUS. And thirdly, the whole bird was frequently wrapped up in this puppet form, and dressed in a mask, like one of the human species.

But as the two others, viz. Dr. GARTHSHORE'S and the SLOANIAN, were externally perfectly similar to the above-mentioned, I am led to conjecture (for in the total want of information from the ancients concerning these small mummies, we must however fix upon some conjecture), that the manufacturers of mummies, who made them for sale, in order to save themselves the trouble of preparing a bird, took a bone, or other solid part of a decayed mummy, or indeed any thing that was nearest at hand, dressed it up as the mummy of an Ibis, and tendered it for sale.

Whoever recollects what a despicable set the Egyptian priests were, even in the time of STRABO, and how the whole religious worship of the Egyptians was then already fallen into decay, will not think this conjecture too gratuitous, or void of probability.

Or shall we rather consider these puppets as the *memento mori* which it is well known the Egyptians were wont to introduce at table in their meals and festivals. HERODOTUS says, that little wooden images were usually carried about for this purpose, and I do actually recollect having seen such small wooden representations of mummies in the British Mu-

In C. Caylus's Recueil.
T. VII. *Pl.* 9. *Fig.* 1.

Bronze.

Fig. 1.

Painted on the back of the Coffin of Capt. Lethieullier's Mummy, in the British Museum.

Fig. 2.

Belonging to M^r. Heyne, F.R.S.

White Marble.

Fig. 3.

Fig 1 & 3 are Idols of Isis with little Horus on her knees.

Fig. 4.

natural size

seum. LUCIAN also relates, as an eye witness, that in his time the dead bodies themselves were introduced at table. It is easy to conceive how, during the long interval of near 700 years, before the transition took place from the first simple idea to this disgusting practice, such little mummies may at some period or other have formed the intermediate step.

The author of the *Recherches sur les Egyptiens* seems unwilling to admit that real mummies had ever been introduced at table: but his scepticism appears to me to be no better founded than the contrary assertion of one of the most eminent physicians of the last century, CASP. HOFFMANN, who in his once classical work *de Medicamentis Officinalibus*, in the section of the Egyptian mummies, gravely relates, that in Lower Saxony no feast was ever given without the introduction of a mummy.* And strange as this *qui pro quo* between an Egyptian corpse and a particular kind of Brunswick strong beer must appear, it is however a fact, that several more modern writers upon mummies have actually copied it out into their works with implicit confidence.

* P. 642. "A Saxonibus audivi, nullum apud ipsos convivium transigi posse, sine "*mummei*, uti appellant. Ita olim sine lasere, et hodie Indi sine asa fœtida nihil co- "medunt. Hinc, qui in Ægyptum eunt afferre secum solent *talia cadavera*."

XV. *Observations on Vision.* *By* David Hosack, *M. D.* *Communicated by* George Pearson, *M. D. F. R. S.*

Read May 1, 1794.

By what power is the eye enabled to view objects distinctly at different distances? As the pupil is enlarged or diminished according to the greater or less quantity of light, and in a certain degree to the distance of the object, it would readily occur that these different changes of the pupil would account for the phænomena in question. Accordingly anatomists and philosophers, who have written upon this subject, have generally had recourse to this explanation.

Amusing myself with these changes of the pupil, as a matter of curiosity, by presenting to the eye different objects at different distances, I soon perceived that its contraction and dilatation were irregular and more limited than had been supposed; *i. e.* that approaching the object nearer the eye, within a certain distance, the pupil not only ceased to contract, but became again dilated; and that beyond a few yards distance, it also ceased to dilate: these circumstances immediately occurred as objections to the above explanation; for were it from the contraction and dilatation of the iris alone that we see objects at different distances, I naturally concluded it should operate regularly to produce its effects; but if to view an object at a few yards distance it be enlarged to the utmost

extent, surely it must of itself be insufficient to view one at the distance of several miles; for example, the heavenly bodies.

Another difficulty here presents itself: in viewing the sun, instead of dilating, according to the distance, it contracts, obeying rather the quantity or intensity of the light, than the distance of the object. Knowing no other obvious power in the eye itself of adapting it to the different distances of objects, it occurred to me to inquire, whether the combined action of the external muscles could not have this effect. I first proposed this query to an optician of eminence in London, and who has written expressly on this subject. I repeated the same question to a celebrated teacher of anatomy. Encouraged by their replies, I have since attended more particularly to the subject, and hope my inquiries have not been altogether unsuccessful. As introductory to a more distinct view of what I have to advance, it appears necessary to premise the following observations, relative to those general laws of vision which are more particularly connected with this part of the subject, and to which we shall have occasion of frequent reference.

1st. Let A B C, (Tab. XVII. fig. 1.) be an object placed before the double convex lens D E, at any distance greater than the radius of the sphere whereof the lens is a segment; the rays which issue from the different points of the object, and fall upon the lens, will be so bent by the refractive power of the glass as to be made to convene at as many other points behind the lens, and at the place of their concourse they will form an image or picture of the object. The distance of the image behind the glass varies in proportion to the distance of the

object before the glass; the image approaching as the object recedes, and receding as that approaches. For if we suppose, (fig. 2.), A and B two radiating points, from which the rays A C, A D, and B C, B D, fall upon the lens C D, it is manifest that the rays from the nearest point A diverge more than those from the more distant point B, the angle at A being greater than that of B ;* consequently the rays from A, whose direction is A E and A F when they pass through the glass, must convene at some point (as G) more distant from the lens than the point H, where the less diverging rays B K and B L from the point B are made to convene; which may also be proved by experiment with the common convex glass.†

It will be necessary to have this proposition in view, as we shall afterwards have occasion to use it in shewing, that by varying the distance between the retina and the anterior part of the eye we are enabled to see objects at different distances.

2d. If an object, as A B, (fig. 3.) be placed at a proper distance before the eye (E), the rays which fall from the several points of the object falling upon the cornea pass through the pupil, and will be brought together by the refractive power of the different parts of the eye on as many corresponding points of the retina, and there paint the image of the object, in the same manner as the images of objects placed before a convex lens are painted upon the spectrum, placed at a proper distance behind it; thus the rays which flow from the point A are united on the retina at C, and those which proceed from B are collected at D, and the rays from all the intermediate points are convened at as many intermediate points of the

* EUCLID, Book I. Prop. 21.

† See KEPLER Diopt. Postul. SMITH's Optics, GRAVESANDE, &c.

retina; on this union of the rays at the retina depends distinct vision. But supposing the eye of a given form, should the point of union lie beyond the retina, as must be the case with those from the less distant object, agreeable to the preceding proposition; or should they be united before they arrive at the retina, as from the more distant object, it is evident that the picture at the retina must be extremely confused. Now as the rays which fall upon the eye from radiating points at different distances have different degrees of divergence, and the divergence of the rays increasing as the distance of the radiating point lessens, and, *vice versa*, lessening as that increases; again, as those rays which have greater degrees of divergence, viz. from the nearer objects, require a stronger refractive power to bring them together at a given distance than what is necessary to make those meet which diverge less, it is manifest, that to see objects distinctly at different distances, either the refractive power of the eye must be increased or diminished, or the distance between the iris and retina be varied, corresponding with the different distances of the objects; both of which probably take place, as will hereafter appear.*

Having then established these as our premises, we shall next examine the different principles which have been employed for explaining vision at different distances.

* "Facile enim intelligitur, quo longius radii adveniunt, eo magis esse parallelos; "eo minus ergo differre ab axi, et eo minoribus viribus corneæ et lentis crystallinæ in "focum cogi. Ut enim corpus magis distat, ita sub minori angulo radii adveniunt. "Contra si corpus conspicuum valde vicinum fuerit, radiorum ab eo advenientium an- "gulus est major, et adeo magis divergentes in oculum incidunt, et viribus egent refrin- "gentibus majoribus omnibus densioribus."—HALLER. Elem. Phys. lib. xvi.

Most writers upon this subject refer this power of the eye to the contraction and dilatation of the iris. Within certain limits this would, upon first examination, as already observed, appear to be the case, since the pupil enlarges as the object is further removed from the eye, and again contracts as it is brought near. The extent of this principle I have already pointed out; but I suspect we also err in attributing to the difference of distance what are only effects of different quantities of light, a circumstance in which it is the more easy to commit error as they are generally proportionate one to the other; *i. e.* as the object is near we require a less degree of light, and to exclude what is superfluous the iris contracts; but as it is more distant, a greater quantity of light becomes necessary, and the iris dilates: thus far we see the use of the enlargement or diminution of the pupil, as the object is more or less distant. But distinct vision does not consist in the quantity of light alone, though too much or too little would obscure the image.

It is also necessary that the rays which flow from the object should fall upon the retina in a certain direction, to form a distinct picture; but surely the greater or less quantity of light, the greater or less number of rays, which it is only the property of the iris to diminish or increase, cannot alter the direction.

But there is still another argument to prove, that the contraction or enlargement of the pupil is not of itself sufficient to produce distinct vision at different distances, viz. that the myopes, whose pupil contracts and dilates as in other eyes, are still unable to adapt the eye to different distances; and the means by which this is remedied certainly does not consist in

a larger or smaller aperture for the rays to pass through, but a power of altering their direction, which the change in the shape of the eye had rendered too convergent. The same fact is also observable in those who squint; the pupil in both eyes equally contracts and dilates, but still the vision of one eye is less perfect than the other. Another principle upon which it has been attempted to explain this power of the eye, is a supposed change in the convexity of the crystalline lens; the ancients had some obscure notion of it, but it has been lately pursued by Mr. THOMAS YOUNG, in a paper published in the Philosophical Transactions of London for 1793. He has endeavoured to demonstrate the existence of muscles in the crystalline lens, and by their action to account for distinct vision at different distances. This opinion deserves here the more particular examination, having met the attention of the Royal Society, and thereby likely to influence the general opinion upon this subject.

That we may not mistake the meaning of the author, I beg leave to premise his description of the structure of the lens. "The crystalline lens of the ox," he observes, "is an orbicular "convex transparent body, composed of a considerable number "of similar coats, of which the exterior closely adhere to the "interior; each of these coats consists of six muscles, inter-"mixed with a gelatinous substance, and attached to six mem-"branous tendons. Three of these tendons are anterior, "three posterior; their length is about two-thirds of the "semidiameter of their coat; their arrangement is that of "three equal and equidistant rays meeting in the axis of the "crystalline; one of the anterior is directed towards the "outer angle of the eye, and one of the posterior towards the

" inner angle; so that the posterior are placed opposite to the " middle of the interstices of the anterior, and planes passing " through each of the six, and through the axis, would mark " on either surface six regular equidistant rays. The muscu- " lar fibres arise from both sides of each tendon, they diverge " till they reach the greatest circumference of the coat, and " having passed it, they again converge till they are attached " respectively to the sides of the nearest tendons of the oppo- " site surface. The exterior or posterior portion of the six, " viewed together, exhibits the appearance of three penni- " formi-radiated muscles."

In the first place, to say nothing of the transparency of muscles, as an argument against their existence, we must unavoidably suppose, as they have *membranous tendons*, which Mr. YOUNG informs us he distinctly observed, that these tendons cannot possess the same degree of transparency and density with the bellies of these muscles; that is, they must possess some degree of opacity, or certainly he could not have pointed out their membranous structure, nor even the tendon itself, as distinct from the body of the muscle; and if they have not the same density, from their situation, and being of a penniform shape, must there not be some irregularity from the difference in the refraction of those rays which pass through the bellies of those muscles, and those again which pass through their membranous tendons? This structure then, of consequence, cannot be well adapted for a body whose regular shape and transparency are of so much consequence.

Again, Mr. YOUNG describes six muscles in each layer; but LEEUWENHOEK, whose authority he admits as accurate, relative to the muscularity of the lens, is certainly more to be attended to in his observation of bodies less minute, viz. as to

the layers themselves, in which these muscles are found, and which of course are larger, and more easily observed; but, with his accuracy of observation, he has computed, that there are near 2000 laminæ; and according to Mr. YOUNG, supposing each layer to contain six muscles, we have necessarily, in all, 12,000 muscles; the action of which certainly exceeds human comprehension. I hope this will not be deemed trifling minuteness, as it is a necessary and regular consequence, if we admit their existence as described.

But secondly, as to the existence of these muscles, I cannot avoid expressing a doubt. With the utmost accuracy I was capable of, and with the assistance of the *best* glasses, to my disappointment, I cannot bear witness to the same circumstances related by Mr. YOUNG, but found the lens perfectly transparent; at the same time, lest it might be attributed to the want of habit in looking through glasses, I beg leave to observe, that I have been accustomed to the use of them in the examination of the more minute objects of natural history. After failing with the glasses in the natural viscid state of the lens, I had recourse to another expedient; I exposed different lenses before the fire to a moderate degree of heat, by which they became opaque and dry; in this state it is easy to separate the layers described by Mr. YOUNG; but although not so numerous as noticed by the accurate LEEUWENHOEK, still they were too numerous to suppose each to have contained six muscles; for I could have shewn distinctly at least fifty layers, without the assistance of a glass, as was readily granted by those to whom I exhibited them.

But a circumstance which would seem to prove that these

layers possess no distinct muscles is, that in this opaque state they are not visible, but consist rather of an almost infinite number of concentric fibres (if the term be at all appropriate) not divided into particular bundles, but similar to as many of the finest hairs of equal thickness, arranged in similar order: see fig. 4, 5, and 6, where the arrangement of the layers and fibres has been painted from the real lens of an ox, and that without the assistance of a glass. To observe this fact, any person may try the experiment at pleasure, and witness the same with the naked eye, even separating many layers and their fibres with the point of a penknife.

This regular structure of layers, and those consisting of concentric fibres, is unquestionably better adapted for the transmission of the rays of light, than the irregular structure of muscles. It may, perhaps, be urged, that the heat to which I exposed the lens may have changed its structure: in answer to that I observe, it was moderate in degree, and regularly applied; of consequence we may presume, as it appeared uniformly opaque, that every part was alike acted upon; but by boiling the lens, where the heat is, without doubt, regularly applied, we observe the same structure.

Thirdly, that it is not from any changes of the lens, and that this is not the most essential organ in viewing objects at different distances, we may also infer from this undeniable fact, that we can, in a great degree, do without it; as after couching or extraction, by which operations all its parts must be destroyed, capsule, ciliary processes, muscles, &c.

Mr. YOUNG asserts, from the authority of Dr. PORTERFIELD, that patients, after the operation of couching, have not

the power of accommodating the eye to the different distances of objects; at present, I believe the contrary fact is almost universally asserted.*

Besides, if the other powers of the eye are insufficient to compensate for the loss of this dense medium, the lens, a glass of the same shape answers the purpose, and which certainly does not act by changing its figure. I grant their vision is not so perfect; but we have other circumstances upon which this can be more easily explained; which will be particularly noticed under the next head. It may not be improper also to observe, that the specific gravity of the crystalline compared with that of the vitreous humour, and of consequence, its density and power of refraction, is not so great as has been generally believed. Dr. BRYANT ROBINSON, by the hydrostatic balance, found it to be nearly as 11 to 10. I have also examined them with the instrument of Mr. SCHMEISSER, lately presented to the Royal Society, and found the same result; of consequence the crystalline lens is not so essentially necessary for vision as has been represented; especially as it is also probable, that upon removing it, the place which it occupied is again filled by the vitreous humour, whose power of refraction is nearly equal. At the same time we cannot suppose the lens an unnecessary organ in the eye, for nature produces

* "Et lente ob cataractam extracta vel deposita oculum tamen ad varias distantias "videre, ut in nobili viro video absque ullo experimento quo eam facultatem recupera- "verit. Etsi enim tunc ob diminutas vires quæ radios uniunt, æger lente vitrea opus "habet, eadem tamen lens in omni distantia sufficit."—HALLER, El. Phys.

"La lentille cristalline n'est cependant point de première necessité pour la vision. "Aujourd'hui, dans l'opération de la cataracte on l'enlève entièrement, et la vision "n'en souffre point."—DE LA METHERIE Vues Physiologiques. See also DE LA HIRE, HAMBERGER Physiolog.

nothing in vain; but that it is not of that indispensable importance, writers upon optics have taught us to believe.

Fourthly, Mr. YOUNG tells us, he has not yet had an opportunity of examining the human crystalline; and grants, that from the spherical form of it in the fish, such a change as he attributes to the lens in quadrupeds cannot take place in that class of animals. The lenses which I have examined in the manner abovementioned were the human, those of the ox, the sheep, the rabbit, and the fish, and in all the same lamellated structure is observable; even in the spherical lens of the fish these lamellæ are equally distinct, but without the smallest appearance of a muscle.

From these circumstances I cannot avoid the conclusion, that they do not exist; at the same time I am persuaded that Mr. YOUNG met with appearances which he supposed were muscles; but I am satisfied he will readily acknowledge, that the examination of the crystalline lens in its viscid glutinous state, is not only attended with much difficulty, but that the smallest change of circumstances might lead to error; which I apprehend may, probably, have been the case in that instance.

Upon examining it after boiling, or exposing it to a gradual degree of heat before the fire, when it may be handled with freedom, he will readily observe (without a glass) the numerous lamellæ, and the arrangement of their fibres, which I have described.

Another opinion has been sanctioned by many respectable writers, of the effects of the ciliary processes in changing the shape and situation of the lens; some supposed it to possess the power of changing the figure of the crystalline, rendering

it more or less convex ;* others, that it removed it nearer to the cornea ;† and others, that it removed it nearer the retina.‡

The advocates for these different opinions all agree in attributing these effects to a supposed muscularity of the ciliary processes.

Of the structure of these processes HALLER observes, " In " omni certe animalium genere processus ciliares absque ulla " musculosa sunt fabrica, mere vasculosi vasculis serpentinis " percursi molli facti membrana." Which structure, I believe, at present is universally admitted. But even supposing them muscular, such is their delicacy of structure, their attachment, and direction, that we cannot possibly conceive them adequate to the effects ascribed to them. Beside, what we observed of the muscles of the lens itself, also applies to the processes, viz. that they may be destroyed, as in couching or extraction, and yet the eye be capable of adapting itself to the different distances of objects. For a more full refutation of these opinions, see HALLER's large work.

The Situation, Structure, and Action of the external Muscles.§

Upon carefully removing the eyelids, with their muscles, we are presented with the muscles of the eye itself, which are six in number ; four called recti, or straight ; and two oblique ;

* DES CARTES, SCHEINERUS, BIDLOUS, MOLLINETTUS, SANCTORIUS, JURIN.

† KEPLER, ZINN, PORTERFIELD.

‡ LA CHARIERE, PERRAULT, HARTSOEKER, BRISSEAU, and DERHAM.

§ For the accuracy of the representation I have annexed (in Tab. XVIII.) I can vouch, having been at much pains in the dissection ; from which I had the painting taken by a most accurate hand, Mr. S. EDWARDS, a gentleman well known for his abilities in the plates of that admirable work, the Flora Londinensis.

so named from their direction, (see Tab. XVIII. fig. 1.) A A A A, the tendons of the recti muscles, where they are inserted into the sclerotic coat, at the anterior part of the eye. B, the superior oblique, or trochlearis, as sometimes called, from its passing through the loop or pulley connected to the lower angle of the orbiter notch in the os frontis; it passes under the superior rectus muscle, and backwards to the posterior part of the eye, where it is inserted by a broad flat tendon into the sclerotic coat. C, the inferior oblique, arising tendinous from the edge of the orbiter process of the superior maxillary bone, passes strong and fleshy over the inferior rectus, and backwards under the abductor to the posterior part of the eye, where it is also inserted by a broad flat tendon into the sclerotic coat. D D D, the fat in which the eye is lodged. In fig. 2. we have removed the bones forming the external side of the orbit, with a portion of the fat, by which we have a distinct view of the abductor. A B C, three of the recti muscles, arising from the back part of the orbit, passing strong, broad, and fleshy over the ball of the eye, and inserted by flat, broad tendons into the sclerotic coat, at its anterior part. D, the tendon of the superior oblique muscle. E, the inferior oblique, fig. 3. A, the abductor of the eye. B, the fleshy belly of the superior oblique, arising strong, tendinous, and fleshy from the back part of the orbit. C, the optic nerve. D and E, the recti muscles.

The use ascribed to these different muscles, is that of changing the direction of the eye, to turn it upwards, downwards, laterally, or in any of the intermediate directions, accommodated either to the different situation of objects, or to express the different passions of the mind, for which they are

peculiarly adapted. But is it inconsistent with the general laws of nature, or even with the animal œconomy, that from their combination they should have a different action, and thus an additional use? To illustrate this we need only witness the action of almost any set of muscles in the body; for example, in lifting a weight, the combined action of the muscles of the arm, shoulder, and chest, is different from the individual action of either set, or of any individual muscle; or an instance nearer our purpose may be adduced, viz the actions of the muscles of the chest and belly, making a compression upon the viscera, as in the discharge of urine, fœces, &c. But to question this fact would be to question the influence of the will in any one of the almost infinite variety of motions in the human body.

I presume, therefore, it will be admitted that we have the same power over these muscles of the eye as of others, and I believe we are no less sensible of their combined action; for example, after viewing an object at the distance of half a mile, if we direct our attention to an object but ten feet distance, every person must be sensible of some exertion; and if our attention be continued but for a short time, a degree of uneasiness and even pain in the ball of the eye is experienced; if again we view an object within the focal distance, *i. e.* within six or seven inches, such is the intensity of the pain that the exertion can be continued but a very short time, and we again relieve it by looking at the more distant objects; this, I believe, must be the experience of every person, whose eyes are in the natural and healthy state, and accordingly has been observed by almost every writer upon optics.

But the power of this combination, even from analogy,

appears too obvious to need further illustration. I shall therefore next endeavour to point out their precise action.

Supposing the eye in its horizontal natural position; I see an object distinctly at the distance of six feet, the picture of the object falls exactly upon the retina; I now direct my attention to an object at the distance of six inches, as nearly as possible in the same line; although the rays from the first object still fall upon my eye, while viewing the second, it does not form a distinct picture on the retina, although at the same distance as before, which shews that the eye has undergone some change; for while I was viewing the first object I did not see the second distinctly, although in the same line: and now, *vice versa*, I see the second distinctly, and not the first; the rays from the first, therefore, as they still fall upon the eye, must either meet before or behind the retina; but we have shewn that the rays from the more distant object convene sooner than those from the less distant object, therefore the picture of the object at six feet falls before, while the other forms a distinct image upon the retina; but as my eye is still in the same place as at first, the retina has by some means or other been removed to a greater distance from the fore part of the eye to receive the picture of the nearer object, agreeable to the principle page 198. From which it is evident, that to see the less distant object either the retina should be removed to a greater distance, or the refracting power of the media should be increased: but I hope we have shewn that the lens, which is the greatest refracting medium, has no power of changing itself. Let us next inquire, if the external muscles, the only remaining power the eye possesses, are capable of producing those changes. With respect to the

anterior part of the eye, we have seen the situation of those muscles; the recti strong, broad, and flat, arising from the back part of the orbit, passing over the ball as over a pulley, and inserted by broad flat tendons at the anterior part of the eye; the oblique inserted toward the posterior part, also by broad flat tendons; when they act jointly, the eye being in its horizontal position, it is obvious, as every muscle in action contracts itself, the four recti by their combination must necessarily make a compression upon the different parts of the eye, and thus elongate its axis, while the oblique muscles serve to keep the eye in its proper direction and situation. For my own part, I have no more difficulty in conceiving of this combination of those muscles than I have at present of the different flexors of my fingers in holding my pen. But other corresponding effects are also produced by this action; not only the distance between the anterior and posterior parts of the eye is increased, but of consequence the convexity of the cornea, from its great elasticity, is also increased, and that in proportion to the degree of pressure, by which the rays of light passing through it are thence necessarily more converged. But another effect, and one not inconsiderable, is, that by this elongation of the eye, the media, viz. the aqueous, crystalline, and vitreous humours through which the rays pass, are also lengthened, of consequence their powers of refraction are proportionably increased; all which correspond with the general principle. It may however be said, that as the four recti muscles are larger and stronger than the two oblique, the action of the former would overcome that of the latter, and thus draw back the whole globe of the eye; but does not the fat at the posterior part of the orbit also afford a resistance

to the too great action of the recti muscles, especially as it is of a firm consistence, and the eye rests immediately upon it? Admitting then that this is the operation of the external muscles when in a state of contraction, it is also to be observed, we have the same power of relaxing them, in proportion to the greater distance of the object, until we arrive at the utmost extent of indolent vision.

But, as a further testimony of what has been advanced, I had recourse to the following experiment, which will shew that the eye is easily compressible, and that the effects produced correspond with the principles I have endeavoured to illustrate.

With the common *speculum oculi* I made a very moderate degree of pressure upon my eye, while directing my attention to an object at the distance of about twenty yards; I saw it distinctly, as also the different intermediate objects; but endeavouring to look beyond it, every thing appeared confused. I then increased the pressure considerably, in consequence of which I was enabled to see objects distinctly at a much nearer than the natural focal distance; for example, I held before my eye, at the distance of about two inches, a printed book; in the natural state of the eye I could neither distinguish the lines nor letters; but upon making pressure with the speculum I was enabled to distinguish both lines and letters of the book with ease.

Such then I conceive to be the action and effects of the external muscles, and which I apprehend will also apply in explaining many other phænomena of vision; some of those it will not be improper at present briefly to notice.

First, may not the action of those muscles have more or less effect in producing the changes of vision which take place

in the different periods of life? At the same time the original conformation of the eye, the diminution of its humours, and, probably, of the quantity of fat upon which the eye is lodged, are also to be taken into the account. But the external muscles becoming irregular and debilitated by old age, in common with every other muscle of the body, are not only incapable of compensating for these losses, but cannot even perform their wonted action, and thus necessarily have considerable influence in impairing vision. Again, does not the habit of long sight so remarkable in sailors and sportsmen, who are much accustomed to view objects at a great distance, and that of short sight, as of watchmakers, seal-cutters, &c. admit of an easy solution upon this principle? as we know of no part of the body so susceptible of an habitual action as the muscular fibre.

Secondly. How are we to account for the weaker action of one eye in the case of squinting? That this is the fact has been well ascertained; Dr. REID * upon this subject observes, that he has examined above twenty persons that squinted, and found in all of them a defect in the sight of one eye. PORTERFIELD and JURIN have made the same observation.

The distorted position of the eye has, I believe, been generally attributed to the external muscles; but no satisfactory reason has ever been given why the eye, directed towards an object, does not see it distinctly at the same distance as with the other. The state of the iris here cannot explain it, as it contracts and dilates in common with the other; nor can we suppose any muscles the lens might possess could have any

* See his Inquiry into the Human Mind, page 322.

effect, as they are not at all connected with the nature of this disease.

But the action of the external muscles, I apprehend, will afford us a satisfactory explanation. When the eye is turned from its natural direction, for example, towards the inner canthus, it is obvious that the *adductor* muscle is shortened, and its antagonist, the *abductor*, lengthened; consequently, as the abductor has not the same power of contracting itself with the adductor, when the eye is directed towards an object, their power of action being different and irregular, the compression made upon the eye and its humours must also be equally irregular, and therefore insufficient to produce the regular changes in the refraction and shape of the eye we have shewn to be necessary in adapting it to the different distances of objects. The effects produced by making a partial pressure upon the eye with the finger, or *speculum oculi*, before noticed, would also appear to favour this explanation.

Thirdly. May it not in part be owing to the loss of this combined action of the external muscles, and the difficulty of recovering it, that the operation of couching is sometimes unsuccessful, especially when the cataract has been of long standing? This cannot be attributed to the iris, for it perhaps, dilates and contracts as before: nor to the muscles of the lens, for they are removed; nor to the state of the nerve, for it is still sensible to light; and yet the patient cannot see objects distinctly; and it is not an uncommon circumstance, even when the operation succeeds, that the sight is slowly and gradually recovered. Instances have occurred, Mr. BELL*

* See his System of Surgery.

observes, of the sight becoming gradually better for several months after the operation.

When we have been long out of the habit of combining our muscles in almost any one action of life, as walking, dancing, or playing upon a musical instrument, we in a great measure lose the combination, and find a difficulty in recovering it, in proportion to the length of time we had been deprived of it; but the individual action of each muscle remains as before. Thus, probably, with the muscles of the eye. A variety of facts of a similar nature must present themselves to every person conversant in the science of optics, which may admit of a similar explanation.

I have thus endeavoured, first, to point out the limited action of the iris, and of consequence the insufficiency of this action for explaining vision. Secondly, to prove that the lens possesses no power of changing its form to the different distances of objects. Thirdly, that to see objects at different distances, corresponding changes of distance should be produced between the retina and the anterior part of the eye, as also in the refracting powers of the media through which the rays of light are to pass. And, fourthly, that the combined action of the external muscles is not only capable of producing these effects, but that from their situation and structure they are also peculiarly adapted to produce them.

Is it not then consistent with every principle in the œconomy of nature and of philosophy, seeing the imperfections of the principles which have hitherto been employed in explaining the phænomena in question, to adopt the one before us, until (agreeable to one of the established rules in philosophizing)

other phænomena occur, by which it may be rendered either more general, or liable to objections?

I have now finished what was proposed. I have declined entering into an extensive view of the structure of the eye, or any of the general principles of optics, as those subjects have been more ably treated in the works already cited, and thus would certainly have destroyed every claim to attention, which these few pages in their present form may possibly possess; and if I should be so fortunate as to succeed in establishing the principle I have proposed, for explaining the phænomena dependent upon this more important organ of our body (if any part possesses a pre-eminence in nature), I also hope it may, in abler hands, admit of some practical application, in alleviating the diseases to which its delicate organization so particularly exposes it.*

* Since the above pages have been written, I have found, upon consulting some of the earliest writers, that the effects of the external muscles did not altogether escape their attention; at the same time they had no distinct idea of their action: I must therefore disclaim the originality of the thought, although I had never met with it before the circumstances already noticed, of the insufficiency of the iris, had suggested it. If, however, I have succeeded in pointing out the precise action of those muscles, and its application to the general principles of vision, in which, I believe, I have never been anticipated, it will be the height of my wishes.

Fig. 1.

Fig. 1.

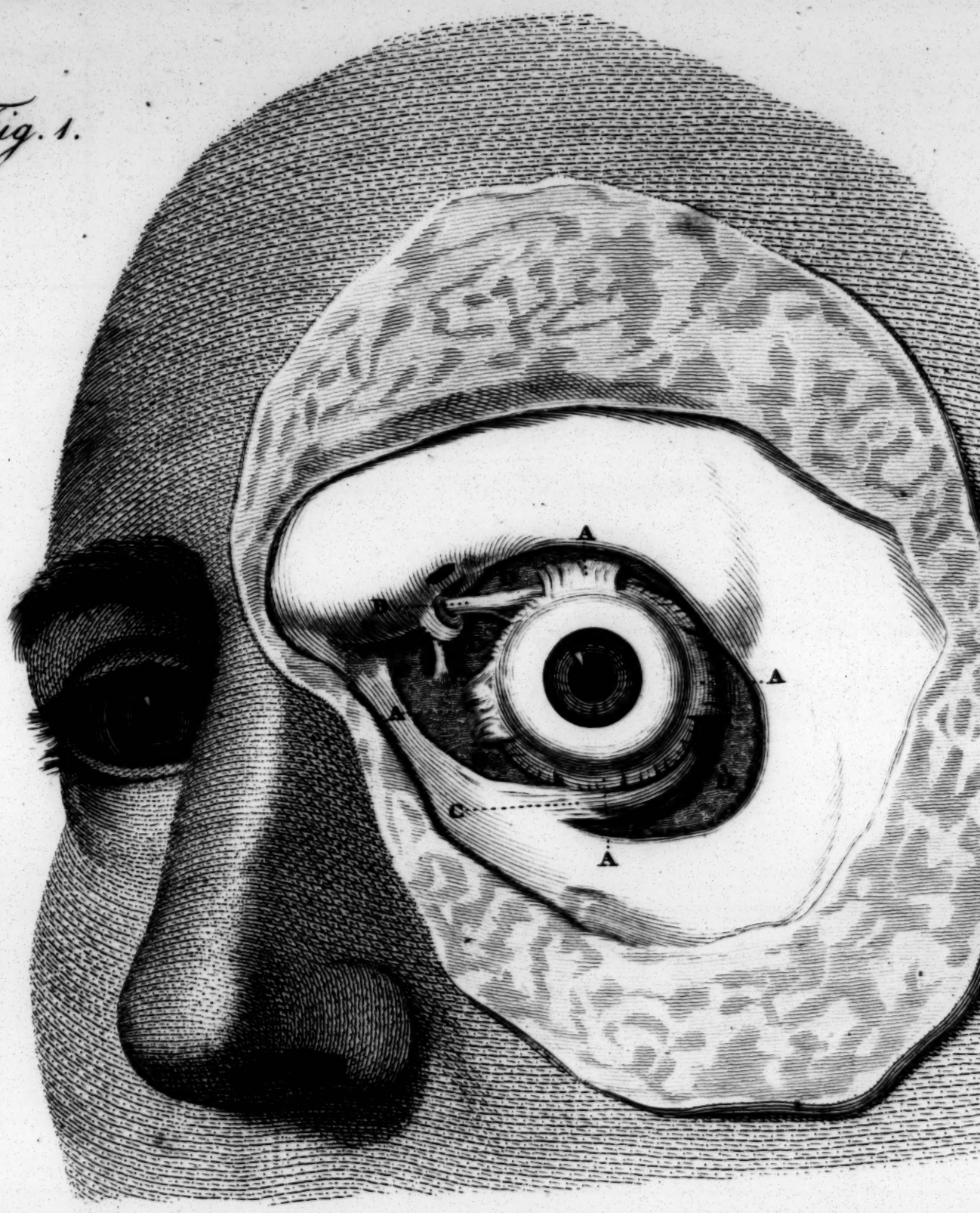

Fig. 2.

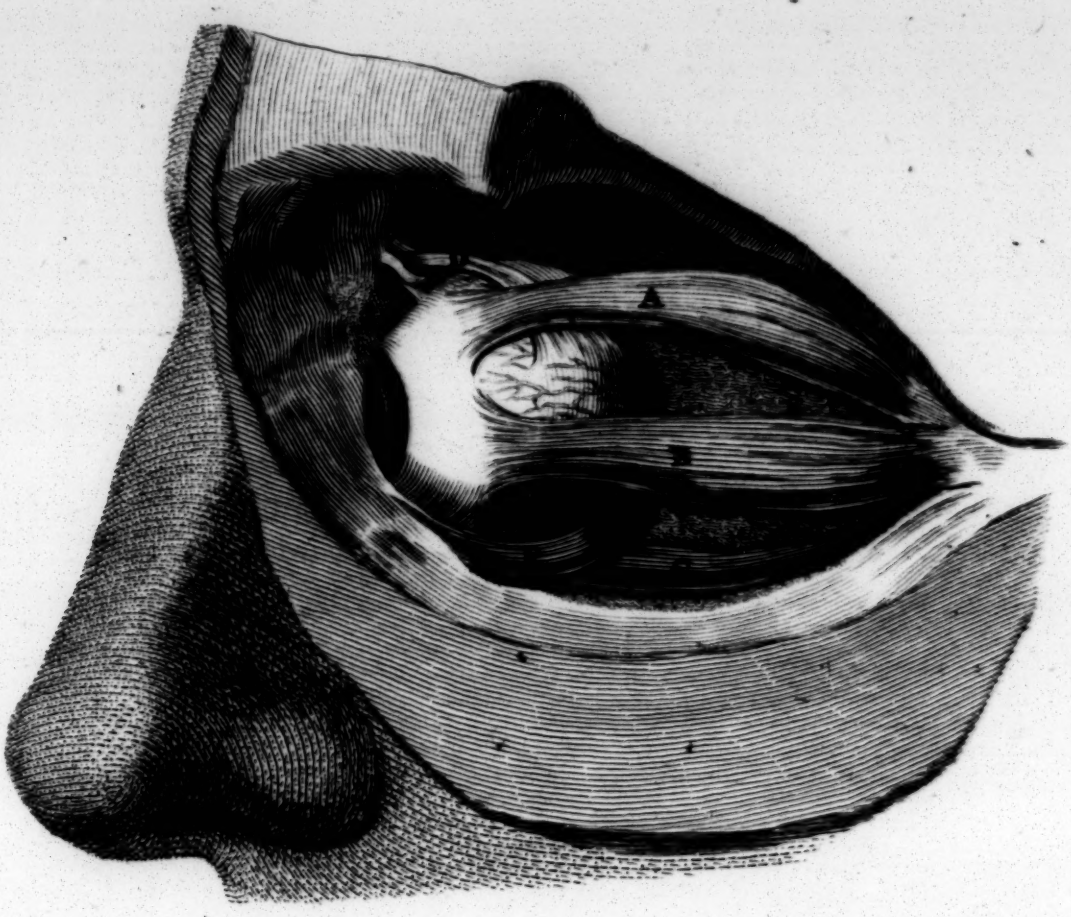

Fig. 3.

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Fig. 1.

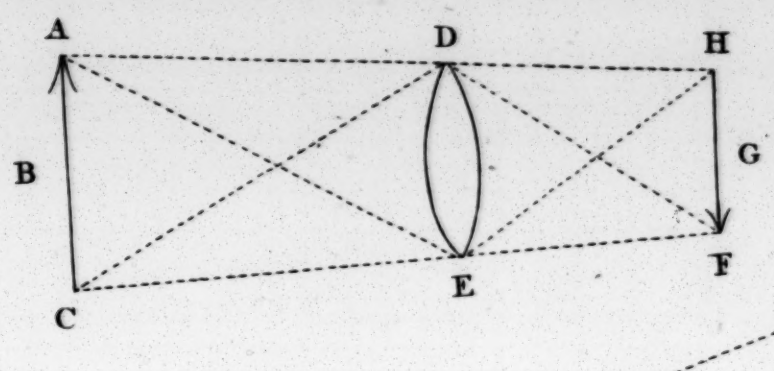


Fig. 2.

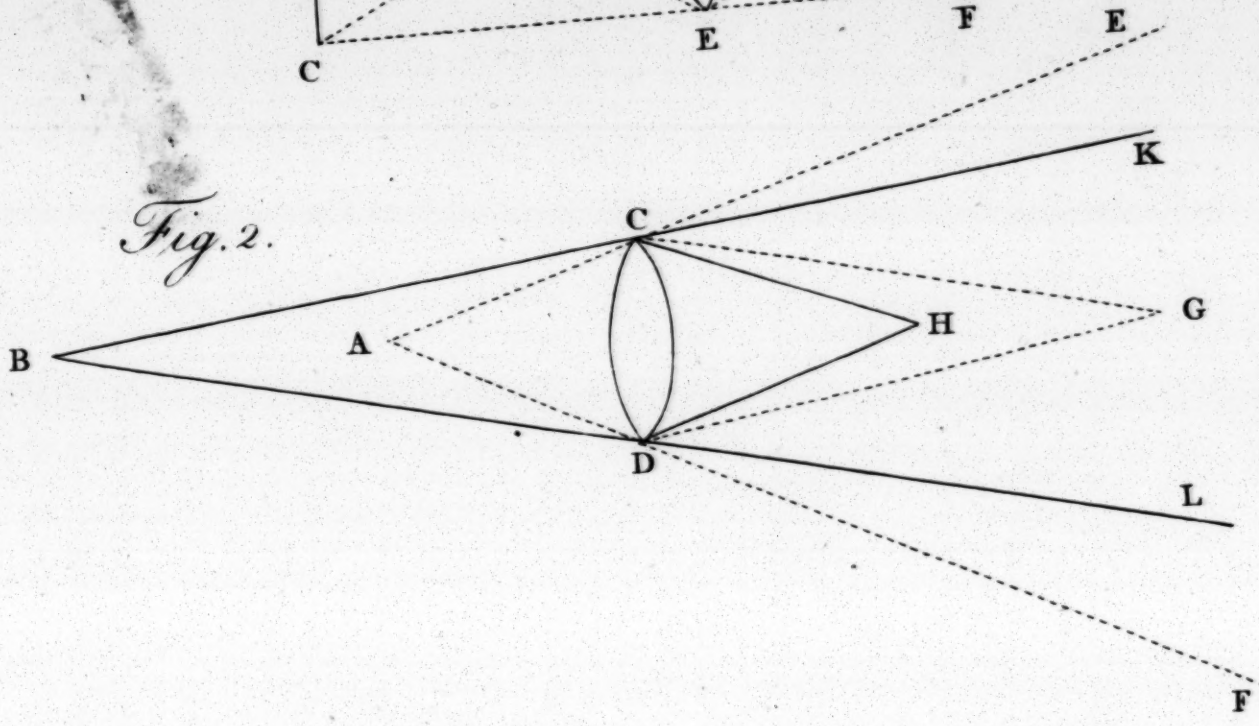


Fig. 3.

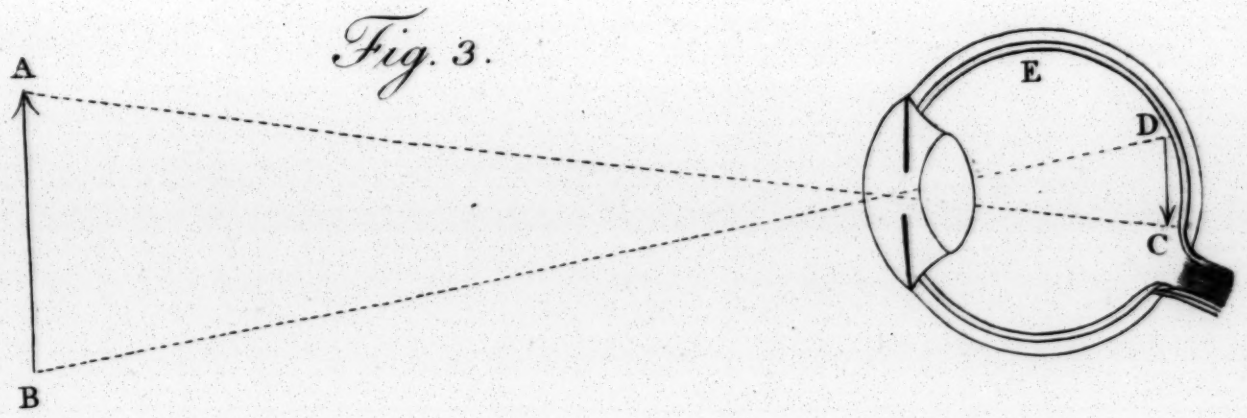


Fig. 4.

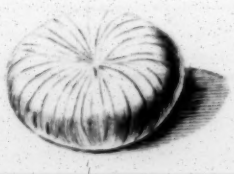


Fig. 5.

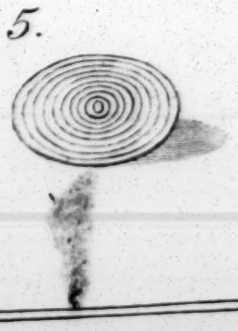


Fig. 6.

XVI. *Dr.* Halley's *Quadrature of the Circle improved: being a Transformation of his Series for that Purpose to others which converge by the Powers of* 80. *By the Rev.* John Hellins, *Vicar of* Potter's Pury, *in* Northamptonshire. *Communicated by* Nevil Maskelyne, *D. D. F. R. S. and Astronomer Royal.*

Read May 15, 1794.

1. Dr. Halley's method of computing the ratio of the diameter of the circle to its circumference was considered by himself, and other learned mathematicians, as the easiest the problem admits of. And although, in the course of a century, much easier methods have been discovered, still a celebrated mathematician of our own times has expressed an opinion, that no other aliquot part of the circumference of a circle can be so easily computed by means of its tangent as that which was chosen by Dr. Halley, viz. the arch of 30 degrees. This opinion, whether it be just or not, I shall not now inquire; my present design being to show, how the series by which Dr. Halley computed the ratio of the diameter to the circumference of the circle, may be transformed into others of swifter convergency, and which, on account of the successive powers of $\frac{1}{10}$ which occur in them, admit of an easy summation.

2. This transformation is obtained by means of different forms in which the fluents of some fluxions may be expressed.

To proceed with the greater clearness, I will here set down the fluxion in a general form, and its fluent, in the two series which are used in the following particular instance, and may be applied with advantage in similar cases.

3. The fluent of $\frac{x^{m-1}\dot{x}}{1-x^n}$ is $= \frac{x^m}{m} + \frac{x^{m+n}}{m+n} + \frac{x^{m+2n}}{m+2n} + \frac{x^{m+3n}}{m+3n}$, &c. which series, being of the simplest form which the fluent seems to admit, was first discovered, and probably is the most generally useful. But it has also been found, that the fluent of the same fluxion may be expressed in series of other forms, which, though less simple than that above written, yet have their particular advantages. Amongst those other forms of series which the fluent admits of, that which suits my present purpose is $\frac{x^m}{m.\overline{1-x^n}} - \frac{n\,x^{m+n}}{m.\overline{m+n}.\overline{1-x^n}^2} + \frac{n.2n.x^{m+2n}}{m.\overline{m+n}.\overline{m+2n}.\overline{1-x^n}^3} - \frac{n.2n.3n.x^{m+3n}}{m.\overline{m+n}.\overline{m+2n}.\overline{m+3n}.\overline{1-x^n}^4} +$ &c. which, to say nothing of other methods, may easily be investigated by the rule given in page 64 of the third edition of EMERSON's Fluxions; or its equality with the former series may be proved by algebra.

4. On account of the sign — before x^n, in the last series, it may be proper to remark, that its convergency by a geometrical progression, will not cease till $\frac{x^n}{1-x^n}$ becomes $= 1$, or x becomes $= \sqrt[n]{\frac{1}{2}}$; and that, when x is a small quantity, and n a large number, this series will converge almost as swiftly as the former. For instance, if x be $= \sqrt{\frac{1}{3}}$, and $n = 8$, which are the values in the following case, the former series will converge by the quantity $x^n = \sqrt{\frac{1}{3}}^8 = \frac{1}{81}$, and this series by the quantity $\frac{x^n}{1-x^n} = \frac{\frac{1}{81}}{1-\frac{1}{81}} = \frac{1}{80}$; where the difference in convergency will be but little, and the divisions by 80 easier than those by 81.

5. With respect to the indices m and n, as they are here supposed to be affirmative whole numbers, and will be so in the use I am about to make of them, the reader need not be detained with any observations on the cases in which these fluents will fail, when the indices have contrary signs.

6. It may be proper further to remark, that by putting $\frac{x^n}{1-x^n} = z$, and calling the first, second, third, &c. terms of the series $\frac{x^m}{m.\overline{1-x^n}} - \frac{n\,x^{m+n}}{m.\overline{m+n.1-x^n}^2} + \frac{n.2n\,x^{m+2n}}{m.\overline{m+n.m+2n.1-x^n}^3} + \&c.$ A, B, C, &c. respectively, the series will be expressed in the concise and elegant notation of Sir ISAAC NEWTON; viz. $\frac{x^m}{m.\overline{1-x^n}} - \frac{nzA}{m+n} + \frac{2nzB}{m+2n} - \frac{3nzC}{m+3n} + \&c.$ which is well adapted to arithmetical calculation.

7. I come now to the transformation proposed, which will appear very easy, as soon as the common series, expressing the length of an arch in terms of its tangent, is properly arranged.

If the radius of a circle be 1, and the tangent of an arch of it be called t, it is well known that the length of that arch will be $= t - \frac{t^3}{3} + \frac{t^5}{5} - \frac{t^7}{7} + \frac{t^9}{9} - \frac{t^{11}}{11} + \&c.$ Now, if the affirmative terms of this series be written in one line, and the negative ones in another, the arch will be

$$= \begin{cases} t + \frac{t^5}{5} + \frac{t^9}{9} + \frac{t^{13}}{13} + \frac{t^{17}}{17} + \&c. \\ -\frac{t^3}{3} - \frac{t^7}{7} - \frac{t^{11}}{11} - \frac{t^{15}}{15} - \frac{t^{19}}{19} - \&c. \end{cases}$$

And if, again, the first, third, fifth, &c. term of each of these series be written in one line, and the second, fourth, sixth, &c. in another, the same arch will be expressed thus:

$$= \left\{ \begin{array}{l} + \left\{ \begin{array}{l} t + \frac{t^9}{9} + \frac{t^{17}}{17} + \frac{t^{25}}{25} + \frac{t^{33}}{33} + \&c. \\ \frac{t^5}{5} + \frac{t^{13}}{13} + \frac{t^{21}}{21} + \frac{t^{29}}{29} + \frac{t^{37}}{37} + \&c. \end{array} \right. \\ - \left\{ \begin{array}{l} \frac{t^3}{3} + \frac{t^{11}}{11} + \frac{t^{19}}{19} + \frac{t^{27}}{27} + \frac{t^{35}}{35} + \&c. \\ \frac{t^7}{7} + \frac{t^{15}}{15} + \frac{t^{23}}{23} + \frac{t^{31}}{31} + \frac{t^{39}}{39} + \&c. \end{array} \right. \end{array} \right.$$

All which series are evidently of the first form in article 3, and therefore their values may be expressed in the second form there given, or more neatly in the NEWTONIAN notation mentioned in art. 6. In each of these series the value of n is 8; and the value of m, $\left\{ \begin{array}{l} \text{in the first series, is } 1; \\ \text{in the second series, is } 5; \\ \text{in the third series, is } 3; \\ \text{in the fourth series, is } 7. \end{array} \right.$

If now we take $t = \sqrt{\frac{1}{3}}$, the tangent of 30°, which was chosen by Dr. HALLEY, we shall have the arch of 30°

$$= \left\{ \begin{array}{l} + \left\{ \begin{array}{l} \frac{1}{\sqrt{3}} \times : 1 + \frac{1}{9.81} + \frac{1}{17\,81^2} + \frac{1}{25\,81^3} + \frac{1}{33.81^4}, \&c. \\ \frac{1}{9\sqrt{3}} \times : \frac{1}{5} + \frac{1}{13.81} + \frac{1}{21.81^2} + \frac{1}{29\,81^3} + \frac{1}{37\,81^4}, \&c. \end{array} \right. \\ - \left\{ \begin{array}{l} \frac{1}{3\sqrt{3}} \times : \frac{1}{3} + \frac{1}{11.81} + \frac{1}{19.81^2} + \frac{1}{27.81^3} + \frac{1}{35.81^4}, \&c. \\ \frac{1}{27\sqrt{3}} \times : \frac{1}{7} + \frac{1}{15.81} + \frac{1}{23.81^2} + \frac{1}{31.81^3} + \frac{1}{39.81^4}, \&c. \end{array} \right. \end{array} \right.$$

Six times this quantity will be = the semicircumference when radius is 1, and = the whole circumference when the diameter is 1. If therefore we multiply the last series by 6, and write $\sqrt{12}$ for $\frac{6}{\sqrt{3}}$, and express their value in the form given in art. 6, we shall have the circumference of a circle whose diameter is 1,

$$= \left\{ \begin{array}{l} + \left\{ \begin{array}{l} \frac{81\sqrt{12}}{80} - \frac{8\,A}{9.80} + \frac{16\,B}{17.80} - \frac{24\,C}{25.80} + \frac{32\,D}{33.80}, \text{ \&c.} \\ \frac{81\sqrt{12}}{5.9.80} - \frac{8\,A}{13.80} + \frac{16\,B}{21.80} - \frac{24\,C}{29.80} + \frac{32\,D}{37.80}, \text{ \&c.} \end{array} \right. \\ \hline - \left\{ \begin{array}{l} \frac{81\ \ 12}{3.3.80} - \frac{8\,A}{11.80} + \frac{16\,B}{19.80} - \frac{24\,C}{27.80} + \frac{32\,D}{35.80}, \text{ \&c.} \\ \frac{81\sqrt{12}}{7.27.80} - \frac{8\,A}{15.80} + \frac{16\,B}{23.80} - \frac{24\,C}{31.80} + \frac{32\,D}{39.80}, \text{ \&c.} \end{array} \right. \end{array} \right.$$

8. All these new series, it is evident, converge somewhat swifter than by the powers of 80. For in the first series, which has the slowest convergency, the coefficients $\frac{8}{9}, \frac{16}{17}, \frac{24}{25}$, &c. are each of them less than 1; so that its convergency is somewhat swifter than by the powers of 80.

9. But another advantage of these new series is, that the numerator and denominator of every term except the first, in each of them, is divisible by 8; in consequence of which the arithmetical operation by them is much facilitated, the division by 80 being exchanged for a division by 10, which is no more than removing the decimal point. These series then, when the factors which are common to both numerators and denominators are expunged, will stand as below, (each of which still converging somewhat quicker than by the powers of 80), and we shall have the circumference of a circle whose diameter is 1,

$$= \left\{ \begin{array}{l} + \left\{ \begin{array}{l} \frac{81\sqrt{12}}{80} - \frac{A}{9.10} + \frac{2\,B}{17.10} - \frac{3\,C}{25.10} + \frac{4\,D}{33.10}, \text{ \&c.} \\ \frac{9\sqrt{12}}{400} - \frac{A}{13.10} + \frac{2\,B}{21.10} - \frac{3\,C}{29.10} + \frac{4\,D}{37\,10}, \text{ \&c.} \end{array} \right. \\ \hline - \left\{ \begin{array}{l} \frac{9\sqrt{12}}{80} - \frac{A}{11.10} + \frac{2\,B}{19.10} - \frac{3\,C}{27.10} + \frac{4\,D}{35.10}, \text{ \&c.} \\ \frac{3\sqrt{12}}{7.80} - \frac{A}{15.10} + \frac{2\,B}{23.10} - \frac{3\,C}{31.10} + \frac{4\,D}{39.10}, \text{ \&c.} \end{array} \right. \end{array} \right.$$

By which series the arithmetical computation will be much more easy than by the original series.

April 30, 1794. J. HELLINS.

XVII. *On the Method of determining, from the real Probabilities of Life, the Values of contingent Reversions, in which Three Lives are involved in the Survivorship.* By William Morgan, *Esq. F. R. S.*

Read May 15, 1794.

In the last paper which I communicated to the Royal Society on the doctrine of survivorships, I concluded with observing that, as far as my own judgment could discover, I had then given rules for determining the values of reversions depending upon three lives in every case which admitted of an exact solution, and that the remaining cases, which were nearly equal in number to those I had already investigated, involved a contingency for which it appeared very difficult to find such a general expression as should not render the rules too complicated and laborious. Since that period I have bestowed much time and attention on this subject, and have at length so far succeeded as to give me reason now to hope that it is capable of being entirely exhausted. It is not my present design to enter into the investigation of all the problems which still remain to be solved. I shall here confine myself to a few of the most important, reserving the conclusion of the subject for some future opportunity.

The contingency to which I have alluded in this and my former paper, as opposing the great difficulty in those problems which I have not yet solved, is that of *one life's failing*

after another in a given time. It becomes necessary, therefore, previous to any other investigation, to deduce a general method of ascertaining such an event, and for this purpose I shall subjoin the following lemma.

LEMMA.

To determine, from any table of observations, the probability that B the elder dies *after* A the younger of two lives, either in any given number of years, or during the whole continuance of the life of B.

SOLUTION.

This event can take place in the first year only by the extinction of both lives, A having died first; the probability of which will be expressed by the fraction $\frac{\overline{b-m}\,.\,a'}{2ab}$.* In the second year the probability will be increased; for the event may have taken place, as above mentioned, in the first year, or the lives may have failed in the second year, A having died first; or B may have died in this year, and A in the first year. The expression, therefore, for the second year will be $\frac{\overline{b-m}\,.\,a'}{2ab} + \frac{\overline{m-n}\,.\,a''}{2ab} + \frac{\overline{m-n}\,.\,a'}{ab} = \frac{1}{ab} \times \frac{\overline{\overline{b \quad n} \quad a'}}{2} + \frac{\overline{\overline{m-n} \quad \overline{\iota \quad +a''}}}{2}$. In the third year the probability will be still further increased; for, in addition to the foregoing contingencies, the event may have taken place by the extinction of the two lives in the third year, A having died first; or by the extinction of the life of A

* In order to avoid unnecessary repetitions, I have uniformly in this paper preserved the same symbols as in my last paper.—See Phil. Trans. Vol. LXXXI. page 247.

in the first or second years, and of the life of B in the third year. Therefore, the probability for the third year will be expressed by $\frac{\overline{b-m}.a'}{2ab} + \frac{\overline{m-n}.a''}{2ab} + \frac{\overline{m-n}.a'}{ab} + \frac{\overline{n-o}.a'''}{2ab} + \frac{\overline{n-o}.\overline{a'+a''}}{ab} = \frac{1}{ab} \times \frac{\overline{b-o}.a'}{2} + \frac{\overline{m-o}.\overline{a'+a''}}{2} + \frac{\overline{n-o}.\overline{a''+a'''}}{2}$. By proceeding in the same manner for the fourth year, the probability will be found $= \frac{1}{ab} \times \frac{\overline{b-p}.a'}{2} + \frac{\overline{m-p}.\overline{a'+a''}}{2} + \frac{\overline{n-p}.\overline{a''+a'''}}{2} + \frac{\overline{o-p}.\overline{a'''+a''''}}{2}$; and supposing x to denote the difference between the ages of B, and of the oldest person in the table, and y and z respectively the number of persons living at the two last ages in the same table, the whole probability of the elder life's dying after the younger will be $= \frac{1}{2ab}$ into $\overline{b-z}.a' + \overline{m-z}.\overline{a'+a''} + \overline{n-z}.\overline{a''+a'''} + \overline{o-z}.\overline{a'''+a''''} \ldots + \overline{y-z}.\overline{a^{x-1}+a^x}$. Now, since it is well known that the probability of both lives failing in x years, without any regard to the order of their extinction, is $= \frac{\overline{b-z} \times \overline{a'+a''+a'''+a''''\ldots+a^x}}{ab}$ (or supposing π to be the number of persons living at the end of x years from the age of A) $= \frac{\overline{b-z}\ \overline{-\pi}}{ab}$, it is evident that, if the foregoing series be subtracted from this fraction, the probability will be obtained of the younger person's dying after the elder in x years. In the first paper which I communicated to the Royal Society on this subject,* I not only described the most concise method of computing a table of the probabilities of survivorship between any two given lives, but computed a comprehensive one for persons of all ages, whose common difference was not less than ten years. As the contingency in this lemma is of considerable

* See Phil. Trans. Vol. LXXVIII. p. 335.

importance, and the solutions of a great number of problems require that it should be previously ascertained, I have computed a similar table on the present occasion; and it will appear from the following operations that both are formed in nearly the same manner.

Ages of B.	A	Probability of B's dying after A.		Probability of A's dying after B.
*95	85	$\frac{1}{4\times186}\times\frac{41\times3}{2}=$	.0827	$\frac{3\times41}{4\times186}-.0827=.0827$
94	84	$\frac{1}{9\times234}\times\frac{48\times8}{2}+\frac{\overline{48+41}\times3}{2}=$	.1546	$\frac{8\times89}{9\times234}-.1546=.1835$
93	83	$\frac{1}{16\times289}\times\frac{55\times15}{2}+\frac{\overline{55+48}\times8}{2}+\frac{\overline{48+41}\times3}{2}=$	.2072	$\frac{15\times144}{16\times289}-.2072=.2599$
92	82	$\frac{1}{24\times346}\times\frac{57\times23}{2}+\frac{\overline{57+55}\times15}{2}+\frac{\overline{55+48}\times8}{2}+\frac{\overline{48+41}\times3}{2}=$	.2422	$\frac{23\times201}{24\times346}-.2422=.3145$
91	81	$\frac{1}{34\times406}\times\frac{60\times33}{2}+\frac{\overline{60+57}\times23}{2}+\frac{\overline{57+55}\times15}{2}+$ &c.$=$	.2696	$\frac{33\times261}{34\times406}-.2696=.3544$
90	80	$\frac{1}{46\times469}\times\frac{63\times45}{2}+\frac{\overline{63+60}\times33}{2}+\frac{\overline{60+57}\times23}{2}+$ &c.$=$	.2864	$\frac{45\times324}{46\times469}-.2864=.3894$
89	79	$\frac{1}{62\times534}\times\frac{65\times61}{2}+\frac{\overline{65+63}\times45}{2}+\frac{\overline{63+60}\times33}{2}+$ &c. $=$	.2907	$\frac{61\times389}{62\times534}-.2907=.4260$

From these specimens it will be readily seen, that the probability between two younger lives is derived from that of the two preceding older ones, without any addition of labour; for the sum of all the terms of the series, excepting the two first, is constantly obtained from the foregoing operations. Thus, when the ages of B and A are 92 and 82, the two terms $\frac{\overline{55+48}\times8}{2}+\frac{\overline{48+41}\times3}{2}$ form a part of the preceding series, which expresses the probability between two persons aged 93 and 83.

* This, and all the other computations in this paper, are deduced from the Northampton Table, in Dr. PRICE's Treatise on Annuities, Vol. II. p. 36. edit. 5th.

And in like manner when their ages are 91 and 81, the three terms $\frac{57+55\times15}{2}+$ &c. form a part of the series which denotes the probability between two persons, aged 92 and 82. By proceeding with these operations, a table may be formed for all lives, whose common difference of age is the same, with little more trouble than in the single case of the two youngest lives. If a table of the probabilities of survivorship be already formed (such as that to which I have referred in my first paper), the operations in the present case may be exceedingly abridged; and it will not perhaps be improper here to explain the manner in which this is effected. By exchanging the symbols c, d, e, &c. in the solution in my first paper, for their equals m, n, o, &c. in the present solution, the series expressing the probability of B's surviving A will become $=\frac{1}{ab}\times\frac{b\,.\,a'}{2}+\frac{m\,.\,a'+a''}{2}+\frac{n\,.\,a''+a'''}{2}\ldots\ldots+\frac{z\,.\,a^x}{2}$, which exceeds the series expressing the probability of B's dying after A by $\frac{z}{ab}\times a'+a''+a'''\ldots\ldots+\frac{a^x}{2}$ (or supposing z, as in the Northampton Table, to be $=1$) by $\frac{a-\pi}{ab}$ nearly. If, therefore, the given probability of B's surviving A be denoted by Y, the probability of B's dying after A will be $=Y-\frac{a-\pi}{ab}$, and the probability of A's dying after B will be $=\frac{a-\pi}{a}-Y$. The following table has been computed in this manner, excepting the first and the two last divisions, where the difference of age between the two lives is 10, 80, and 90 years. In these cases, the probabilities have been deduced from the series in this lemma, and chiefly with the view of proving the accuracy of the table in my first paper. It is

however necessary to observe, that in the abovementioned series $\frac{z}{ab} \times \overline{a' + a'' + a''' + \ldots\ldots \frac{a^x}{2}}$, the last term, $\left(\frac{a^x}{2}\right)$ by supposing the whole series $= \frac{a-\pi}{ab}$, is taken $= a^x$, and therefore the difference between Y and the probability of B's dying after A, is not *exactly* expressed above. Regard has been had to this circumstance in the following table, in all cases where the age of the eldest life exceeds 86 years. But under that age it is omitted, as the expression $\frac{a-\pi}{ab}$ becomes then true to four places of decimals, and of consequence sufficiently correct for any useful purpose.

TABLE,

Shewing the probability of one life's dying after another.*

Ten years difference.			Twenty years difference.			Thirty years difference.			Forty years difference.		
Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.
1 11	.3973	.5858	1 21	.3885	.5244	1 31	.3384	.4821	1 41	.2908	.4355
2 12	.4664	.5136	2 22	.4536	.4431	2 32	.3934	.3934	2 42	.3355	.3396
3 13	.4962	.4822	3 23	.4803	.4086	3 33	.4155	.3555	3 43	.3526	.2983
4 14	.5176	.4597	4 24	.4934	.3898	4 34	.4307	.3284	4 44	.3642	.2686
5 15	.5297	.4469	5 25	.5028	.3767	5 35	.4382	.3133	5 45	.3694	.2518
6 16	.5417	.4342	6 26	.5120	.3638	6 36	.4456	.2983	6 46	.3746	.2351
7 17	.5501	.4252	7 27	.5183	.3546	7 37	.4498	.2881	7 47	.3777	.2228
8 18	.5559	.4190	8 28	.5223	.3482	8 38	.4533	.2796	8 48	.3791	.2138
9 19	.5586	.4159	9 29	.5237	.3450	9 39	.4541	.2751	9 49	.3788	.2084
10 20	.5591	.4152	10 30	.5232	.3439	10 40	.4532	.2731	10 50	.3772	.2057
11 21	.5583	.4157	11 31	.5223	.3438	11 41	.4516	.2722	11 51	.3747	.2043
12 22	.5571	.4167	12 32	.5209	.3440	12 42	.4497	.2716	12 52	.3719	.2033
13 23	.5558	.4178	13 33	.5187	.3449	13 43	.4476	.2712	13 53	.3690	.2024
14 24	.5544	.4189	14 34	.5179	.3445	14 44	.4453	.2709	14 54	.3659	.2016
15 25	.5530	.4201	15 35	.5162	.3449	15 45	.4430	.2706	15 55	.3626	.2009
16 26	.5513	.4215	16 36	.5144	.3454	16 46	.4405	.2704	16 56	.3591	.2003
17 27	.5500	.4225	17 37	.5128	.3456	17 47	.4381	.2699	17 57	.3551	.1994
18 28	.5490	.4232	18 38	.5117	.3452	18 48	.4360	.2688	18 58	.3523	.1978
19 29	.5486	.4233	19 39	.5109	.3442	19 49	.4342	.2670	19 59	.3491	.1956
20 30	.5485	.4230	20 40	.5105	.3427	20 50	.4325	.2648	20 60	.3459	.1928
21 31	.5490	.4221	21 41	.5105	.3406	21 51	.4312	.2618	21 61	.3428	.1893
22 32	.5498	.4209	22 42	.5107	.3382	22 52	.4298	.2586	22 62	.3399	.1852
23 33	.5506	.4196	23 43	.5110	.3356	23 53	.4284	.2553	23 63	.3244	.1809
24 34	.5515	.4183	24 44	.5110	.3332	24 54	.4268	.2519	24 64	.3339	.1765
25 35	.5524	.4169	25 45	.5112	.3306	25 55	.4253	.2484	25 65	.3307	.1719
26 36	.5533	.4155	26 46	.5112	.3280	26 56	.4235	.2449	26 66	.3274	.1673
27 37	.5543	.4140	27 47	.5113	.3253	27 57	.4212	.2413	27 67	.3238	.1626
28 38	.5553	.4125	28 48	.5114	.3225	28 58	.4199	.2376	28 68	.3201	.1578

* In the table in the LXXVIIIth Vol. of the Philosophical Transactions, the *certainty* of one life's surviving the other is denoted by 100. In this table the *certainty* of both lives becoming extinct is denoted by unity, this number being better suited to the solution in the following problems. It may not be improper to add, that both tables, though deduced from the decrements of life at Northampton, may be safely used, even when the values of the life annuities are derived from a different source, as the probabilities they express are very nearly the same, from whatever table of observations they are computed.

Ten years difference.			Twenty years difference.			Thirty years difference.			Forty years difference.		
Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.
29 39	.5562	.4110	29 49	.5115	.3196	29 59	.4179	.2338	29 69	.3164	.1528
30 40	.5573	.4094	30 50	.5115	.3167	30 60	.4159	.2299	30 70	.3122	.1479
31 41	.5583	.4078	31 51	.5112	.3140	31 61	.4136	.2260	31 71	.3077	.1430
32 42	.5592	.4063	32 52	.5108	.3113	32 62	.4112	.2220	32 72	.3029	.1380
33 43	.5601	.4048	33 53	.5104	.3085	33 63	.4089	.2177	33 73	.2977	.1331
34 44	.5608	.4034	34 54	.5099	.3057	34 64	.4066	.2134	34 74	.2921	.1282
35 45	.5613	.4022	35 55	.5092	.3029	35 65	.4037	.2089	35 75	.2858	.1237
36 46	.5625	.4003	36 56	.5086	.3000	36 66	.4009	.2043	36 76	.2788	.1194
37 47	.5635	.3986	37 57	.5072	.2969	37 67	.3978	.1997	37 77	.2715	.1150
38 48	.5646	.3968	38 58	.5071	.2939	38 68	.3945	.1950	38 78	.2637	.1106
39 49	.5655	.3951	39 59	.5051	.2909	39 69	.3910	.1902	39 79	.2559	.1057
40 50	.5664	.3934	40 60	.5049	.2878	40 70	.3872	.1854	40 80	.2470	.1014
41 51	.5669	.3920	41 61	.5038	.2845	41 71	.3829	.1805	41 81	.2384	.0960
42 52	.5676	.3904	42 62	.5026	.2810	42 72	.3785	.1753	42 82	.2286	.0910
43 53	.5684	.3886	43 63	.5017	.2770	43 73	.3736	.1699	43 83	.2174	.0865
44 54	.5692	.3868	44 64	.5007	.2728	44 74	.3681	.1647	44 84	.2040	.0834
45 55	.5701	.3849	45 65	.4995	.2685	45 75	.3617	.1598	45 85	.1898	.0803
46 56	.5709	.3830	46 66	.4982	.2641	46 76	.3544	.1553	46 86	.1743	.0776
47 57	.5708	.3811	47 67	.4967	.2596	47 77	.3465	.1508	47 87	.1576	.0751
48 58	.5723	.3792	48 68	.4950	.2550	48 78	.3383	.1460	48 88	.1393	.0731
49 59	.5729	.3773	49 69	.4945	.2503	49 79	.3308	.1407	49 89	.1214	.0700
50 60	.5737	.3751	50 70	.4907	.2455	50 80	.3207	.1351	50 90	.1032	.0649
51 61	.5748	.3725	51 71	.4885	.2400	51 81	.3105	.1293	51 91	.0865	.0569
52 62	.5762	.3695	52 72	.4860	.2342	52 82	.2993	.1234	52 92	.0691	.0476
53 63	.5778	.3662	53 73	.4830	.2284	53 83	.2864	.1180	53 93	.0520	.0363
54 64	.5792	.3629	54 74	.4793	.2227	54 84	.2706	.1143	54 94	.0324	.0252
55 65	.5811	.3591	55 75	.4747	.2173	55 85	.2530	.1110	55 95	.0126	.0126
56 66	.5830	.3551	56 76	.4691	.2122	56 86	.2338	.1079			
57 67	.5848	.3511	57 77	.4628	.2070	57 87	.2127	.1049			
58 68	.5868	.3467	58 78	.4561	.2013	58 88	.1891	.1025			
59 69	.5886	.3423	59 79	.4494	.1947	59 89	.1657	.0979			

Ten years difference.			Twenty years difference.			Thirty years difference.		
Ages.		Youngest.	Eldest.	Ages.		Youngest.	Eldest.	Ages.		Youngest.	Eldest.
60	70	.5904	.3377	60	80	.4421	.1876	60	90	.1424	.0909
61	71	.5921	.3330	61	81	.4332	.1808	61	91	.1204	.0801
62	72	.5937	.3281	62	82	.4175	.1740	62	92	.0973	.0674
63	73	.5946	.3236	63	83	.4103	.1683	63	93	.0740	.0520
64	74	.5950	.3193	64	84	.3935	.1649	64	94	.0467	.0364
65	75	.5942	.3159	65	85	.3737	.1626	65	95	.0184	.0184
66	76	.5921	.3133	66	86	.3512	.1607				
67	77	.5896	.3106	67	87	.3256	.1591				
68	78	.5868	.3075	68	88	.2956	.1586				
69	79	.5848	.3030	69	89	.2651	.1549				
70	80	.5822	.2981	70	90	.2338	.1473				
71	81	.5784	.2936	71	91	.2032	.1338				
72	82	.5729	.2893	72	92	.1695	.1166				
73	83	.5649	.2860	73	93	.1335	.0933				
74	84	.5508	.2866	74	94	.0878	.0682				
75	85	.5342	.2871	75	95	.0361	.0361				
76	86	.5148	.2868								
77	87	.4912	.2869								
78	88	.4601	.2899								
79	89	.4260	.2907								
80	90	.3894	.2864								
81	91	.3544	.2696								
82	92	.3145	.2422								
83	93	.2599	.2072								
84	94	.1835	.1546								
85	95	.0827	.0827								

Fifty years difference.			Sixty years difference.			Seventy years difference.			Eighty years difference.		
Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.	Ages.	Youngest.	Eldest.
1 51	.2419	.3914	1 61	.1957	.3491	1 71	.1544	.3045	1 81	.1294	.2485
2 52	.2761	.2885	2 62	.2184	.2411	2 72	.1622	.1942	2 82	.1189	.1426
3 53	.2879	.2444	3 63	.2245	.1950	3 73	.1604	.1484	3 83	.1042	.1027
4 54	.2954	.2126	4 64	.2276	.1617	4 74	.1573	.1156	4 84	.0901	.0756
5 55	.2979	.1946	5 65	.2275	.1426	5 75	.1523	.0977	5 85	.0768	.0626
6 56	.3005	.1766	6 66	.2275	.1235	6 76	.1477	.0795	6 86	.0649	.0484
7 57	.3011	.1633	7 67	.2266	.1090	7 77	.1433	.0657	7 87	.0546	.0377
8 58	.3014	.1533	8 68	.2251	.0980	8 78	.1390	.0550	8 88	.0457	.0294
9 59	.2998	.1472	9 69	.2226	.0910	9 79	.1346	.0481	9 89	.0382	.0239
10 60	.2972	.1440	10 70	.2194	.0870	10 80	.1301	.0440	10 90	.0318	.0203
11 61	.2940	.1420	11 71	.2156	.0843	11 81	.1250	.0414	11 91	.0274	.0158
12 62	.2906	.1404	12 72	.2114	.0822	12 82	.1193	.0392	12 92	.0204	.0140
13 63	.2870	.1388	13 73	.2070	.0802	13 83	.1137	.0375	13 93	.0149	.0105
14 64	.2833	.1373	14 74	.2022	.0785	14 84	.1068	.0366	14 94	.0091	.0071
15 65	.2793	.1359	15 75	.1973	.0768	15 85	.0993	.0361	15 95	.0035	.0035
16 66	.2751	.1347	16 76	.1909	.0764	16 86	.0912	.0360			
17 67	.2707	.1332	17 77	.1845	.0755	17 87	.0821	.0362			
18 68	.2662	.1311	18 78	.1780	.0739	18 88	.0723	.0360			
19 69	.2617	.1283	19 79	.1713	.0714	19 89	.0623	.0350			
20 70	.2570	.1250	20 80	.1643	.0685	20 90	.0525	.0327			
21 71	.2524	.1208	21 81	.1569	.0649	21 91	.0433	.0286			
22 72	.2476	.1162	22 82	.1490	.0610	22 92	.0342	.0235			
23 73	.2424	.1116	23 83	.1405	.0574	23 93	.0253	.0177			
24 74	.2369	.1071	24 84	.1305	.0548	24 94	.0155	.0121			
25 75	.2308	.1028	25 85	.1201	.0523	25 95	.0059	.0059			
26 76	.2242	.0987	26 86	.1091	.0499						
27 77	.2174	.0945	27 87	.0975	.0476						
28 78	.2103	.0902	28 88	.0851	.0456						
29 79	.2031	.0856	29 89	.0731	.0427						
30 80	.1956	.0809	30 90	.0615	.0389						
31 81	.1876	.0763	31 91	.0510	.0335						
32 82	.1788	.0720	32 92	.0402	.0277						
33 83	.1692	.0680	33 93	.0298	.0209						
34 84	.1580	.0650	34 94	.0183	.0143						
35 85	.1460	.0624	35 95	.0059	.0059						
36 86	.1333	.0598									
37 87	.1198	.0574									
38 88	.1052	.0553									
39 89	.0909	.0523									
40 90	.0770	.0481									
41 91	.0641	.0420									
42 92	.0509	.0350									
43 93	.0380	.0265									
44 94	.0235	.0182									
45 95	.0090	.0090									

Ninety years difference.		
Ages.	Youngest.	Eldest.
1 91	.1098	.1803
2 92	.0759	.0844
3 93	.0510	.0480
4 94	.0291	.0234
5 95	.0110	.0110

In the solution of all the problems which involve the contingency in the foregoing table, the constant method of ascertaining it has hitherto been, by taking half the probability of the two lives becoming extinct in a given time, both in the case of the elder life's dying after the younger, and of the younger's dying after the elder. When the ages of the two lives are very different, this method (as I have observed in my former paper) must be incorrect. I have taken considerable pains to determine the extent of the inaccuracy, and for this purpose have computed the following table.

TABLE,

Shewing the value, at 4 per cent. of £ 1, payable at the end of a given time, provided the life of B shall have failed after the life of A.

Ages.		5 years.		10 years.		15 years.		20 years.		25 years.		30 years.		40 years.		Life.	
B*	A	True val.	Approx.	True val.	Approx.	True val.	Approx.	True val.	Approx.	True val.	Approx.	True val.	Approx.	True val.	Approx.	True val.	Approx.
20	10	.00134	.00133	.00448	.00472	.00889	.00979	.01382	.01513	.01879	.02030	.02304	02457	.02978	.03118	.02099	.02473
35	15	.00194	.00206	.00732	.00785	.01452	.01528	.02245	.02316	.02977	.03041	.03588	.03667	.04392	.04528	.03153	03936
45	15	.00250	.00266	.00883	01017	.01882	.01980	.02835	02958	.03710	.03838	.04456	04599			.03663	.04829
50	30	.00504	.00503	.01654	.01656	.03057	.03087	.04454	.04523	.05723	.05872	.06639	.06897			.05197	.06819
55	15	.00347	.00369	.01173	01377	.02464	.02640	.03710	.03925	.04683	.05000					.04022	.05644
65	20	.00725	.00730	.02402	.02410	.04203	.04326	.05460	.05898	.05525	.06692					.04696	.06800
70	40	.01413	.01421	.04303	.04477	.06948	.07697									.06688	.10334
75	60	.03357	.03572	.09545	10372	.12293	.15521									.11324	.17570
80	70	.07653	.08051	.15576	.18868											.15915	.23503
85	10	.01136	.01374													.01987	.03500

* In these specimens (which are sufficient to give an idea of the difference between the true values and the approximation in all cases) I have constantly supposed the life of B to be the eldest. But the differences would have been the same if his life had been the youngest; only that in this case the true values would have varied as much in *excess* as they here do in *defect*. This is obvious from the nature of the approximation.

From this table it appears, that the approximations and exact values do not differ much from each other till the last years of B's life, and that the principal inaccuracy in adopting the approximation will arise after the extinction of the life of B, when it becomes necessary to multiply the fraction expressing the probability of his dying after A into the remaining series of the solution. But this perhaps will be better understood from the following problems, and from the computations which are made to prove the correctness of the general rules.

PROBLEM I.

To find the value of an annuity on the life of C after A, on the particular condition that A's life when it fails shall fail before the life of B.

SOLUTION.

As the approximation appears from the preceding table to be always sufficiently correct, except in the two or three last years of B's life, it is evident, that if the fractions which express the probability of B's dying after A in those years, be either confined only to the value of the annuity during that short period, or be not involved at all in the computation, no great inaccuracy will arise from having recourse to the ordinary method of determining that probability, provided the solution be founded on real observations of life, and not on Mr. DE MOIVRE's hypothesis. In the present problem, when C or A is the oldest of the three lives, the abovementioned fractions either never enter into the computation, or are confined to the last years of A's life; and in both cases they are combined

with another contingency, which necessarily renders them of less consequence. The solution, therefore, particularly in the former case, becomes very easy; and even in the latter, by the assistance of the table in my first paper,* it becomes equally simple and correct. But when B is the oldest of the three lives, the above fractions are combined with a series which is often of considerable importance, and consequently the common method of solution fails in this case. Yet even here, being possessed of the table deduced from the foregoing lemma, it is attended with little or no difficulty, and a general rule as short and accurate is obtained as in the other cases. This however will be more satisfactorily proved by the following operations.

1st. *Let C be the oldest of the three lives.* In the first year the payment of the annuity depends on one or other of two events; either that A and B both die (B having died last), and that C lives, the probability of which event is expressed by $\frac{a' \cdot \overline{b-m} \cdot d}{2abc}$, or that only A dies, and that B and C both live, which probability is expressed by $\frac{a'md}{abc}$. The value, therefore, of the annuity for the first year will be $= \frac{a'bd}{2abcr} + \frac{a'md}{2abcr}$. In the second year, the payment of the annuity depends nearly on the same events: 1st. that A and B both die in the first or second year (B having died last), and that C lives to the end of this term, which is $= \frac{e}{c} \times \frac{\overline{b-n} \cdot \overline{a'+a''}}{2ab}$; or 2dly, that only A has died before the end of the second year, and that B and C have both lived, which is $= \frac{ne \cdot \overline{a'+a''}}{abc \cdot}$. Hence the value of the annuity for the

* Phil. Trans. Vol. LXXVIII. p. 337.

second year will be $= \frac{be \cdot \overline{a'+a''}}{2abcr^2} + \frac{ne \cdot \overline{a'+a''}}{2abcr^2}$. In the third year, by following the same steps, the value of the annuity will be found $= \frac{bf \cdot \overline{a'+a''+a'''}}{2abcr^3} + \frac{of \cdot \overline{a'+a''}\,\overline{+a'''}}{2abcr^3}$, and in the remaining years of C's life the value of the annuity may be determined in a similar manner. The whole value of the annuity therefore, when C is the oldest of three lives, will be expressed by the two series $\frac{d'd}{2acr} + \frac{\overline{a'+a''} \cdot e}{2acr^2} + \frac{\overline{a'+a''+a'''} \cdot f}{2acr^3} +$ &c. and $\frac{a'md}{2abcr} + \frac{\overline{a'+a''} \cdot ne}{2abcr^2} + \frac{\overline{a'+a''+a'''} \cdot of}{2abcr^3} +$ &c. The first of these series is $= \frac{C-AC}{z}$, and the second is $= \frac{BC-ABC}{z}$; hence the required value in this case is $= \frac{C-AC}{z} + \frac{BC-ABC}{z}$.

Secondly. *Let A be the oldest of the three lives*, and if z denote the number of years between the ages of A and of the last person in the table, C′ the value of an annuity on the life of C for z years, and B′C′ the same value on the two joint lives of B and C; the value of the annuity for the first z years will evidently in this case be $= \frac{C'-AC}{z} + \frac{B'C'-ABC}{z}$. At the expiration of this term the life of A is necessarily extinct, and consequently the value of the annuity for the remaining years of C's life (supposing δ, ε, ζ, η, &c. to denote the number of persons living in the table at the end of $\overline{z+1}$, $\overline{z+2}$, $\overline{z+3}$, &c. years, and φ to denote the probability of B's surviving A*) will be $= \varphi \times \overline{\frac{\delta}{cr^{z+1}} + \frac{\varepsilon}{cr^{z+2}} + \frac{\zeta}{cr^{z+3}} + \text{&c.}} = \varphi \cdot \overline{C-C'}$. The whole value of the annuity therefore, when A is the oldest

* See the table in the LXXVIIIth Vol. of the Phil. Trans. p. 337. N. B. When this table is used in the present and following problems, certainty must be denoted by *unity*.

of the three lives, will be $= \frac{C'+B'C'}{2} + \varphi \cdot \overline{C-C'} - \frac{AC+ABC}{2}$.

Thirdly. *If B be the oldest of the three lives,* let x denote the number of years between the ages of B and of the last person in the table, C′ the value of an annuity on the life of C for x years, A′C′ the same value on the joint lives of A and C, and π the probability (found by the table in the foregoing lemma), that B dies after A. Then, by proceeding as above, the value of the annuity in this case will be found $= \frac{C'-A'C'}{2} + \pi \times \overline{C-C'} + \frac{BC-ABC}{2}$.. Q. E. D.

When the lives are all equal, the general rule deduced either from the series or the foregoing expressions becomes $= \frac{C-CCC}{2}$, which is known to be the exact value in this case from self-evident principles.

As this method of solution is applicable to a great number of problems, I have thought it necessary to make the following computations, with the view of determining how far it may be depended upon. It is to be observed, that the first series of fractions in the above solution, or $\frac{a' \cdot \overline{b-m} \cdot d}{2abcr} + \frac{\overline{a'+.''} \cdot \overline{b-n}\ e}{2abcr^2} +$ &c. should have been (according to the lemma), in order to express the exact value, $\frac{a' \cdot \overline{b-m} \cdot d}{2abcr} + \frac{a' \cdot \overline{b-n} \cdot + \overline{a'+.''}\ \overline{m\ n} \cdot e}{2abcr^2} +$ &c. and that it is impossible to find a general expression which shall be equal to this latter series and at the same time fit for use. This has rendered it necessary to have recourse to the present approximation. But in the first column of the following examples, each term of this last series has been separately computed, so that by comparing the values in that and the second column an exact idea may be formed of the accuracy of the preceding rules.

Ages of			Annuity of £ 1.					
C.	B.	A.	True value.			Approximation.		
78	15	75	-	-	.138	-	-	.146
70	20	65		-	.406		-	.408
81	70	80	-	-	.530	-	-	.550
15	85	10		-	13.833		-	13.782
15	75	15	-	-	11.385	-	-	11.230
35	75	15		-	8.968		-	8.834
15	65	20	-	-	8.485	-	-	8.379
15	80	70		-	9.893		-	9.529
15	10	85	-	-	.647	-	-	.698
15	15	75		-	1.038		-	1.193
35	15	75	-	-	.786	-	-	.920
15	20	65		-	1.769		-	1.876
15	70	80	-	-	4.307	-	-	4.671

From these examples it appears, that when C or A is the oldest of the three lives, the approximated and the true values agree sufficiently near for any useful purpose; and that even when B is the oldest, the difference is almost as inconsiderable. It should likewise be observed, that these examples are cases in which the difference is likely to be greatest, and therefore a nearer approximation need not be required. Both Mr. SIMPSON and myself have given solutions of this problem, and in most of the foregoing examples the values derived from them are more correct than could have been expected; but these solutions being founded on a wrong hypothesis, are not so correct as the present, except when C is the oldest of the

three lives, nor are they even more simple, so that it can now be seldom necessary to have recourse to them. Without the assistance of the preceding lemma, and the computations which have been just made, it would not have been possible to have ascertained the degree of accuracy of any approximation; and therefore were no other end answered by them, this of itself would be of sufficient consequence to deserve the time and labour which I have bestowed upon this subject. But it will appear, in the solution of some of the succeeding problems, that the use and application of this lemma, and especially of the table deduced from it, are much more extensive and important.

PROBLEM II.

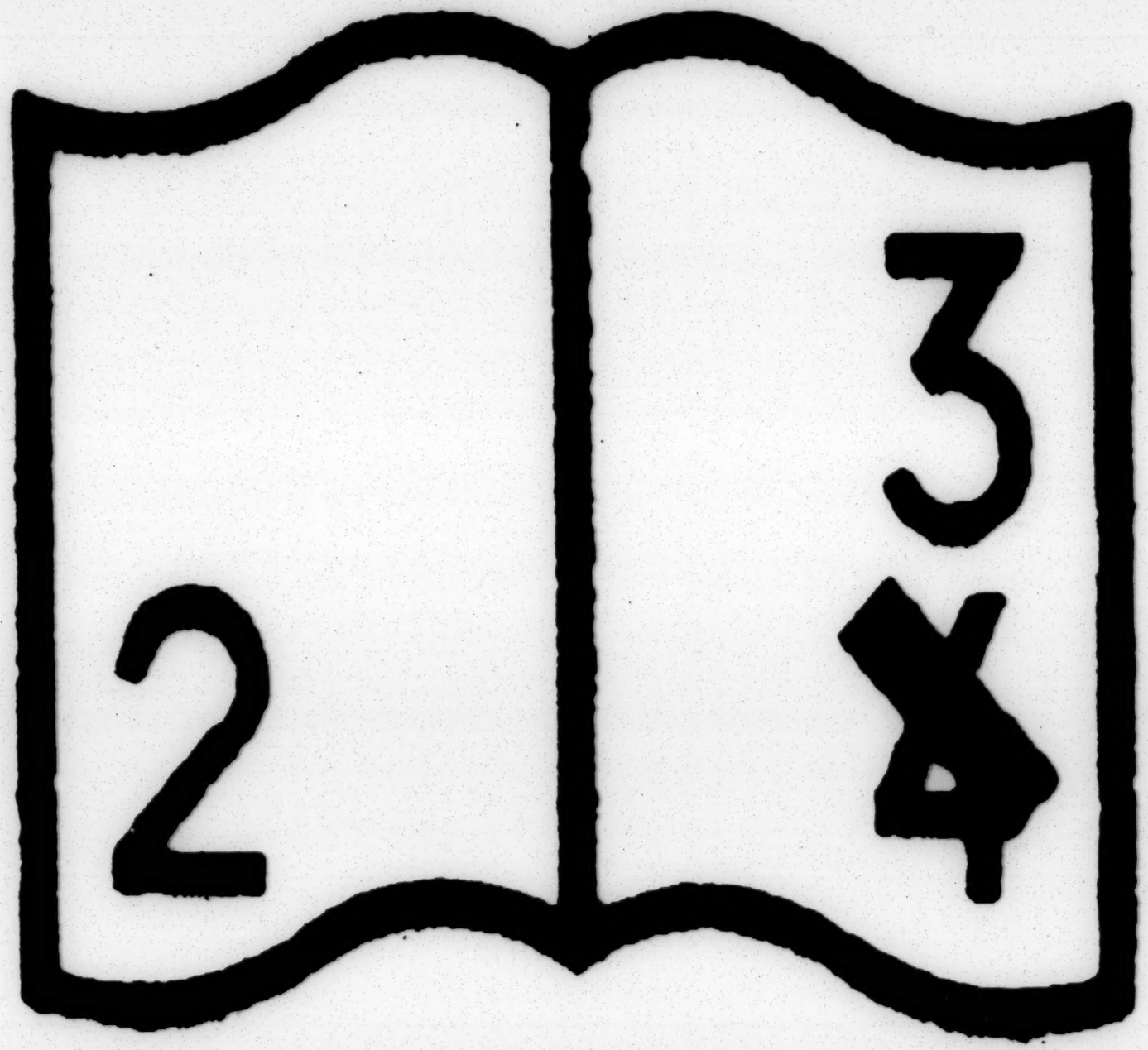
To find the value of an annuity during the life of C, after the decease of A, provided A should survive B.

SOLUTION.

The payment of this annuity depends only on one contingency; and that is, the extinction of the two lives of A and B before the end of each year (B having died first), and the continuance of the life of C to the end of those respective years. The value therefore of the annuity for the first year will be $= \frac{d \cdot \overline{b-m} \cdot a'}{2abcr}$, for the second year $= \frac{e \cdot \overline{b-n} \cdot \overline{a'+a''}}{2abcr^2}$, for the third year $= \frac{f \cdot \overline{b-o} \cdot \overline{a'+a''+a'''}}{2abcr^3}$, and so on for the remaining years. The value of the annuity (*when C is the oldest life*) will consequently be expressed by the two series $\frac{da'}{2acr} + \frac{e \cdot \overline{a'+a''}}{2acr^2} +$

$\frac{f \cdot \overline{a' + a'' + a'''}}{2acr^3}$ + &ç. . . . and $- \frac{mda'}{2abcr} - \frac{ne \cdot \overline{a' + a''}}{2abcr^2} - \frac{of \cdot \overline{a' + a'' + a'''}}{2abcr^3} -$ &c. $= \frac{C - AC}{2} - \frac{BC - ABC}{2}$. If *A be the oldest of the three lives* this rule will be insufficient. Let z, C′, B′C′ and φ denote the the same quantities as in the second part of the preceding problem; then will the value of the annuity in this case, for the first z years, be $= \frac{C' - AC}{2} - \frac{B'C' - ABC}{2}$, and its value for the remaining years of C's life $= \overline{1 - \varphi} \cdot \overline{C - C'}$; for the payment of it during this last term depends on the contingency of C's living so long, and of A's having survived B, which probability is $= 1 - \varphi$; therefore the whole value will be $= C - \frac{C' + B'C'}{2} - \varphi \cdot \overline{C - C'} - \frac{AC - ABC}{2}$.

If B *be the oldest of the three lives*, let x, π, C′, A′C′, δ, ϵ, ζ, &c. denote the same quantities as in the third part of the foregoing problem; also let x' denote the sum of the decrements of the life of A for x years, and α', α'', α''', &c. the decrements of the same life in the $\overline{x + 1}$st, $\overline{x + 2}$d, $\overline{x + 3}$d, &c. years. The value of the annuity for the first x years will it is evident be $= \frac{C' - A'C'}{2} - \frac{BC - ABC}{2}$. In the $\overline{x + 1}$st year the payment of it will depend on the contingency of A's having died after B in $\overline{x + 1}$ years, and C's having lived to the end of this term. As the life of B becomes necessarily extinct in x years, it is plain that the probability of A's dying after him in $\overline{x + 1}$ years must be $= \frac{x' + \alpha'}{a} - \pi$, and therefore that the value of the annuity in this year will be $= \frac{x' + \alpha'}{a} \times \frac{\delta}{cr^{x+1}} - \frac{\pi \cdot \delta}{cr^{x+1}}$. In the same manner the value of the annuity in the $\overline{x + 2}$d,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3

three lives, nor are they even more simple, so that it can now be seldom necessary to have recourse to them. Without the assistance of the preceding lemma, and the computations which have been just made, it would not have been possible to have ascertained the degree of accuracy of any approximation; and therefore were no other end answered by them, this of itself would be of sufficient consequence to deserve the time and labour which I have bestowed upon this subject. But it will appear, in the solution of some of the succeeding problems, that the use and application of this lemma, and especially of the table deduced from it, are much more extensive and important.

PROBLEM II.

To find the value of an annuity during the life of C, after the decease of A, provided A should survive B.

SOLUTION.

The payment of this annuity depends only on one contingency; and that is, the extinction of the two lives of A and B before the end of each year (B having died first), and the continuance of the life of C to the end of those respective years. The value therefore of the annuity for the first year will be $= \frac{d \cdot \overline{b-m} \cdot a'}{2abcr}$, for the second year $= \frac{e \cdot \overline{b-n} \cdot \overline{a'+a''}}{2abcr^2}$, for the third year $= \frac{f \cdot \overline{b-o} \cdot \overline{a'+a''+a'''}}{2abcr^3}$, and so on for the remaining years. The value of the annuity (*when C is the oldest life*) will consequently be expressed by the two series $\frac{dd'}{2acr} + \frac{e \cdot \overline{a'+a''}}{2acr^2} +$

$\frac{f.\overline{a'+a''+a'''}}{2acr^3}$ + &c. . . . and $-\frac{mda'}{2abcr} - \frac{ne.\overline{a'+a''}}{2abcr^2} - \frac{of.\overline{a'+a''+a'''}}{2abcr^3} -$ &c. $= \frac{C-AC}{2} - \frac{BC-ABC}{2}$. If *A be the oldest of the three lives* this rule will be insufficient. Let z, C′, B′C′ and ϕ denote the the same quantities as in the second part of the preceding problem; then will the value of the annuity in this case, for the first z years, be $= \frac{C'-AC}{2} - \frac{B'C'-ABC}{2}$, and its value for the remaining years of C's life $= \overline{1-\phi}.\overline{C-C'}$; for the payment of it during this last term depends on the contingency of C's living so long, and of A's having survived B, which probability is $= 1-\phi$; therefore the whole value will be $= C - \frac{C'+B'C'}{2} - \phi.\overline{C-C'} - \frac{AC-ABC}{2}$.

If B *be the oldest of the three lives*, let x, π, C′, A′C′, δ, ϵ, ζ, &c. denote the same quantities as in the third part of the foregoing problem; also let x' denote the sum of the decrements of the life of A for x years, and α', α'', α''', &c. the decrements of the same life in the $\overline{x+1}$st, $\overline{x+2}$d, $\overline{x+3}$d, &c. years. The value of the annuity for the first x years will it is evident be $= \frac{C'-A'C'}{2} - \frac{BC-ABC}{2}$. In the $\overline{x+1}$st year the payment of it will depend on the contingency of A's having died after B in $\overline{x+1}$ years, and C's having lived to the end of this term. As the life of B becomes necessarily extinct in x years, it is plain that the probability of A's dying after him in $\overline{x+1}$ years must be $= \frac{x'+\alpha'}{a} - \pi$, and therefore that the value of the annuity in this year will be $= \frac{x'+\alpha'}{a} \times \frac{\delta}{cr^{x+1}} - \frac{\pi.\delta}{cr^{x+1}}$. In the same manner the value of the annuity in the $\overline{x+2}$d,

$\overline{x+3}$d, &c. years will be $= \frac{x'+a'+a''}{a} \times \frac{i}{cr^{x+2}} - \frac{\pi . i}{cr^{x+3}}$ . . . . . $\frac{x'+a'+a''+a'''}{a} \times \frac{\zeta}{cr^{x+3}} - \frac{\pi . \zeta}{cr^{x+3}}$ . . . &c. But the series $\frac{x'+a'}{a} \times \frac{\delta}{cr^{x+1}}$ $+ \frac{x'+a'+a''}{a} \times \frac{i}{cr^{x+2}} +$ &c. is $= \overline{C - C'} - \overline{AC - A'C'}$, and the series $\frac{\pi . \delta}{cr^{x+1}} + \frac{\pi . i}{cr^{x+2}} +$ &c. is $= \pi . \overline{C - C'}$, the whole value of the annuity therefore, when B is the eldest, will be $=$ $C - AC - \frac{C' - A'C'}{2} - \frac{BC - ABC}{2} - \pi . \overline{C - C'}$.

COROLLARY.

If the solution of either of these two problems be given, the solution of the other problem may be immediately derived from it; for the value of the reversion in one is no more than the difference between the value of the reversion in the other, and the value of an annuity on the life of C after A. In other words, let the value found by either of these problems be called Q, and the required value of the reversion in the other problem, supposing the ages of A, B, and C to be the same in both, will be $= \overline{C - AC} - Q$. This deduction is self-evident, and if applied to any of the foregoing rules will be found to confirm the truth of the solution.

PROBLEM III.

To find the value of a given sum payable on the death of A and C, provided B should survive one life in particular (A).

SOLUTION.

In the first year the payment of the given sum will depend upon either of two events; 1st, that all the three lives shall drop (B having survived A) which is $= \frac{\overline{b-m} \cdot \overline{c-d} \cdot a'}{2abc}$. 2dly, That B shall live, and only A and C die, which is $= \frac{\overline{c-d} \cdot ma'}{abc}$. The value therefore of the given sum in the first year will be $= \frac{S \cdot a'}{abcr} \times \overline{\frac{bc}{2} + \frac{mc}{2} - \frac{bd}{2} - \frac{md}{2}}$. In the second and following years the payment of S will depend upon either of seven events: 1st. that all the three lives drop in the year, B having survived A. 2dly, That B lives, and only A and C die in the year. 3dly, that A dies in the year, C dies in any of the foregoing years, and B lives. 4thly, That B dies after A in the year, and C dies in any of the foregoing years. 5thly, That C dies in the year, and B dies after A in any of the foregoing years. 6thly, That B and C both die in the year, and A dies in any of the foregoing years. And 7thly, That C dies in the year, A in any of the foregoing years, and B lives. From the several fractions expressing these contingencies the value of the given sum will be found $= \frac{S}{2ab} \times \overline{\frac{a'b}{r} + \frac{a''m}{r^2} + \frac{a'''.n}{r^3} + \&c.} + \frac{S}{2ab} \times \overline{\frac{a'm}{r} + \frac{a''n}{r^2} + \frac{a'''.o}{r^3} + \&c.} - \frac{S}{2abc} \times \overline{\frac{a'bd}{r} + \frac{a''me}{r^2} + \frac{a'''nf}{r^3} + \&c.} - \frac{S}{2abc} \times \overline{\frac{a'md}{r} + \frac{a''ne}{r^2} + \frac{a'''of}{r^3} + \&c.} + \frac{S}{2acr} \times \overline{\frac{a'd}{r} + \frac{\overline{a'+a''} \cdot e}{r^2} + \&c.} + \frac{S}{2abcr} \times \overline{\frac{a'md}{r} + \frac{\overline{a'+a''} \cdot ne}{r^2} + \&c.} - \frac{S}{2acr} \times \overline{\frac{a'e}{r} + \frac{\overline{a'+a''} \cdot f}{r^2} + \&c.} - \frac{S}{2abcr} \times \overline{\frac{a'me}{r} + \frac{\overline{a'+a''} \cdot nf}{r^2} + \&c.} = E + \frac{S}{2r} \times \overline{\overline{C-CA}-\overline{r-1}} \cdot \overline{\overline{BC-ABC}} - \frac{S \cdot \beta}{2b} \times \overline{FC-AFC} + \frac{S \cdot d}{2cr} \times \overline{\frac{m \cdot \overline{PT-APr}}{b}} -$

$\overline{\overline{T-AT}}$. If *A be the oldest of the three lives*, let z, C', $B'C'$, and φ denote the same quantities as in the second part of prob. I, and let $F'C'$ be the value of the joint lives of F and C for z years, it will then be evident that the value of the reversion for the first z years will be $= E + \frac{S}{2r} \times \overline{\overline{C'-A'C'-r-1}}.$ $\overline{\overline{B'C'-ABC}} - \frac{S.\beta}{2b} \times \overline{\overline{F'C'-AFC}} + \frac{S.d}{2cr} \times \overline{\frac{m.\overline{P'T'-AP'T}}{b}} - \overline{\overline{T'-AT}}$, and its value after this term $= \frac{S.\overline{r-1}}{r^{z+1}} \times \frac{\varphi.k}{c} \times \overline{V-C^z}$; C^z being the value of an annuity on a life z years older than C, and k the number of persons living at the age of C^z... If *B be the oldest of the three lives*, the value, by proceeding as above, may be easily found $= E + \frac{S}{2r} \times \overline{\overline{C'-A'C'-r-1}.\overline{BC-ABC}} - \frac{S.\beta}{2b} \times \overline{FC-AFC} + \frac{S.d}{2cr} \times \overline{\frac{m.\overline{PT-AP'T}}{b} - \overline{T'-A'T'}} + \frac{S.\overline{r-1}}{r^{x+1}} \times \frac{\pi.q}{c} \times \overline{V-C^x}$; C', $A'C'$, π and x denoting the same quantities as in the third part of prob. I, C^x the value of an annuity on a life x years older than C, q the number of persons living at the age of C^x.. and T' and $A'T'$ the values of annuities on the single life of T, and on the joint lives of A and T for x years.

But the solution of this problem may be obtained rather more easily by the assistance of the first problem in this paper, and of the second problem which I communicated to the Royal Society in the year 1788.* For the value of a given sum payable on the death of A and C should B survive A, is evidently "the difference between the value of that sum depending on "the contingency of B's surviving A, and the value of an

* Phil. Trans. Vol. LXXVIII. p. 341.

"annuity equal to the interest of the given sum during the life "of C after A, provided A should die before B." The first of these is E, and if an annuity of £ 1. by prob. I, be denoted by Q, the second will be $= \frac{S.\overline{r-1}.Q}{r}$. The required value therefore will be $= E - \frac{S.\overline{r-1}.}{r} \times Q$..... If *the three lives be equal*, the general theorem will become $= \frac{S.\overline{r-1}.}{r} \times \overline{V - CC}$ $\overline{-C - CCC}$, which may be derived from either of the foregoing rules, or from the different series given above.

PROBLEM IV.

To find the value of a given sum S, payable on the death of A and C, should B die before one life in particular (A).

SOLUTION.

The payment of S in the first year depends on the contingency of the three lives having become extinct (A having survived B), which is expressed by $\frac{\overline{b-m}.\overline{c-d}.a'}{2abc}$, and therefore the value of S in this year will be $= \frac{S.a'}{2abcr} \times \overline{bc - mc - bd + ma'}$. In the second and following years the sum S will become payable if either of five events should take place. 1st, If the *three lives* should drop in the year (B having died before A). 2dly, If C should die in any of the preceding years, and A die after B in that particular year. 3dly, If B and C should die in any of the preceding years, and only A die in that year. 4thly, If B should die in any of the preceding

years, and A and C both die in that year: and 5thly, If A should die after B in any of the preceding years, and C die in that year. From the different fractions expressing those probabilities, the value of S may be found $= \frac{S}{a} \times \overline{\frac{a'}{r} + \frac{a''}{r^2} + \frac{a'''}{r^3} + \&c.}$

$+ \frac{S}{acr} \times \overline{\frac{da'}{r} + \frac{e \cdot \overline{a' + a''}}{r^2} + \&c.} - \frac{S}{2ab} \times \overline{\frac{a'm}{r} + \frac{a''n}{r^2} + \frac{a''' \cdot o}{r^3} + \&c.} +$

$\frac{S}{2abc} \times \overline{\frac{a'bd}{r} + \frac{a''me}{r^2} + \frac{a''' \cdot nf}{r^3} + \&c.} + \frac{S}{2abc} \times \overline{\frac{a'md}{r} + \frac{a''ne}{r^2} + \frac{a'''of}{r^3} + \&c.}$

$- \frac{S}{2acr} \times \overline{\frac{da'}{r} + \frac{e \cdot \overline{a' + a''}}{r^2} + \&c.} - \frac{S}{2abcr} \times \overline{\frac{a'md}{r} + \frac{\overline{a' + a''} \cdot ne}{r^2} + \&c.} +$

$\frac{S}{2acr} \times \overline{\frac{ea'}{r} + \frac{f \cdot \overline{a' + a''}}{r^2} + \&c.} + \frac{S}{2abcr} \times \overline{\frac{a'me}{r} + \frac{\overline{a' + a''} \cdot nf}{r^2} + \&c.}$ The three first of these series are $= \frac{S \cdot \overline{r-1}}{r} \times \overline{V - A - C + AC}$, and the remaining eight denote the value of S by the third problem, with contrary signs. If this last value be called Y, and the value of an annuity of £ 1. on the longest of the two lives of A and C be called Z, the required value will be $= \frac{S \cdot \overline{r-1}}{r} \times \overline{V - Z - Y}$; that is, the value of the given sum in this case is "the difference between its value after the extinc-" tion of the lives of A and C, on the contingency of B's sur-" viving A, and the whole value of the reversion after the " death of A and C, without any restriction." This rule is self-evident, and proves the truth of the foregoing investigations. The solution of this problem may also be derived from the second problem in this paper, and the third problem in my paper communicated in the year 1788.* In other words, "the " value of S in the present case is equal to the difference be-" tween its value after the death of A and B, provided B

* Phil. Trans. Vol. LXXVIII. p. 347.

" should die before A, and the value of an annuity equal to " the interest of S during the life of C after A, provided A " should survive B." Let the first of these values be denoted by W, and the second by X, and the required value will be $=$ $W - \frac{S \cdot \overline{r-1}}{r} \times X$. When the three lives are equal, the value of the reversion evidently becomes $= \frac{S \cdot \overline{r-1}}{2r} \times \overline{V - L}$, which expression may be easily derived from either of the rules given above, or immediately from the series themselves.

Having given so many examples of the accuracy of the rules in the first and second problems, it becomes unnecessary to add any further examples in regard to the two foregoing problems, as the solutions of the latter are derived from those of the former, and consequently are equally correct in all cases.

PROBLEM V.

To find the value of a given sum payable on the *decease* of B and C, should their lives be the *last* that shall fail of the three lives A, B, and C.

SOLUTION.

In the first year the given sum can be received only provided the three lives shall have failed, and the life of A have been the first that became extinct. In the second and following years it may be received provided either of four events shall have happened: 1st, If all the three lives shall have failed in that year, A dying first. 2dly, If A shall have died in any of the foregoing years, and B and C both died in that

year. 3dly, If B and A shall have both died in the foregoing years (B dying last), and C died in that year. 4thly, If C and A shall have both died in the foregoing years (C dying last), and B died in that year. From the fractions expressing these several contingencies the value of the reversion will be found

$$= \frac{S}{3abc} \times \overline{\frac{a'bc}{r} + \frac{a''md}{r^2} + \frac{a'''ne}{r^3} + \&c.} - \frac{S}{3abc} \times \overline{\frac{a'mc}{r} + \frac{a''nd}{r^2} + \frac{a'''oe}{r^3} + \&c.}$$

$$- \frac{S}{2abcr} \times \overline{\frac{nd \cdot a'}{r} + \frac{eo \cdot \overline{a'+a''}}{r^2} + \&c.} - \frac{S}{3abc} \times \overline{\frac{a'bd}{r} + \frac{a''me}{r^2} + \frac{a'''nf}{r^3} +}$$

$$\overline{\&c.} - \frac{S}{2abcr} \times \overline{\frac{me \cdot a'}{r} + \frac{nf \cdot \overline{a'+a''}}{r^2} + \&c.} + \frac{S}{3abc} \times \overline{\frac{a'md}{r} + \frac{a''ne}{r^2} + \frac{a'''of}{r^3}}$$

$$\overline{+ \&c.} + \frac{S}{abcr} \times \overline{\frac{a'ne}{r} + \frac{\overline{a'+a''} \cdot of}{r^2} + \&c.} + \frac{S}{2acr} \times \overline{\frac{\overline{d-e} \cdot a'}{r} + \frac{\overline{e-f} \cdot \overline{a'+a''}}{r^2}}$$

$$\overline{+ \&c.} + \frac{S}{2abr} \times \overline{\frac{\overline{m-n} \cdot a'}{r} + \frac{\overline{n-o} \cdot \overline{a'+a''}}{r^2} + \&c.} = S \text{ into } \frac{\overline{r-1}}{r} \cdot \times$$

$$\overline{\frac{V-ABC}{3} - \frac{B+C}{2} + BC - \frac{AB+AC}{2r} + \frac{m}{2br} \times 1 + AP} - \frac{PC-APC}{3}$$

$$+ \frac{d}{2cr} \times \overline{1 + AT} - \frac{BT-ABT}{3} - \frac{4m \cdot \overline{1+APT}}{3b} - \frac{\beta \cdot \overline{FC-AFC}}{3b} - \frac{\varkappa}{3c} \times$$

$$\overline{\overline{BK-ABK} + \frac{\beta \cdot AFK}{b}}.$$

If B and C are both of them older than A, and also are nearly of the same age, this general rule will be sufficiently correct. But if the ages of B and C differ much from each other, it is evident that the annuity on the single life of the younger of them (suppose C), and on the joint lives of AC and AT, ought to be continued only for as many years as are equal to the difference between the age of B and of the oldest life in the table of observations. In this case also there is a further value of S, after the necessary extinction of the life of B, arising from the contingency of that life's having failed after the life of A, and of C's having failed after both of them. Let x, π, C′, and A′C′ respectively denote the same

values as in the third part of the first problem, and let A′T′ denote the value of an annuity on the joint lives of A and T for x years, P′ the value of an annuity on the life of P for the same term, C^x the value of an annuity on a life x years older than C, and k the number of persons living in the table at that age, then will the value of the given sum be in this case

$$= S \text{ into } \overline{\frac{r-1 \,.\, \overline{BC-ABC}}{3r} + \frac{x}{3c} \times \frac{\beta \,.\, \overline{FK-AFK}}{b}} - \overline{BK-ABK} - \overline{\frac{\beta \,.\, \overline{FC-AFC}}{3b} + \frac{m}{2br} \times \frac{4d \,.\, \overline{PT-APT}}{3c} - \frac{PC-APC}{3}} - \overline{P'-A'P'} - \overline{\frac{d}{2cr} \times \frac{BT-ABT}{3} + \overline{T'-A'T'}} + \frac{B+C'-\overline{AB+A'C'}}{2r} + \frac{\pi \,.\, k \,.\, \overline{r-1}}{6r^{x+1}} \times \overline{V-C^x}.$$

If A be the oldest of the three lives, it will be necessary to substitute $\overline{a-s}$, $\overline{s-t}$, $\overline{t-u}$, &c. for their equals a', a'', a''', &c. and b', b'', b''', &c. for their equals $\overline{b-m}$, $\overline{m-n}$, $\overline{n-o}$, &c. In this case let C be supposed the oldest of B and C, and the series expressing the value of the reversion during the life of A will become

$$\frac{2 \,.\, S}{3abc} \times \overline{\frac{adb'}{r} + \frac{esb''}{r^2} + \frac{ftb'''}{r^3} + \&c. + \frac{S}{2abcr} \times \overline{\frac{esb'}{r} + \frac{ft \,.\, \overline{b'+b''}}{r^2} + \&c. + \frac{S}{3abc} \times \overline{\frac{dsb'}{r} + \frac{etb''}{r^2} + \frac{fub'''}{r^3} + \&c. - \frac{S}{6abc} \times \overline{\frac{acb'}{r} + \frac{dsb''}{r^2} + \frac{etb'''}{r^3} + \&c. - \frac{S}{2abcr} \times \overline{\frac{dsb'}{r} + \frac{et \,.\, \overline{b'+b''}}{r^2} + \&c. - \frac{S}{3abc} \times \overline{\frac{csb'}{r} + \frac{dtb''}{r^2} + \frac{eub'''}{r^3} + \&c. + \frac{S}{2b} \times \overline{\frac{b'}{r} + \frac{b''}{r^2} + \frac{b'''}{r^3} + \&c. - \frac{S}{2ab} \times \overline{\frac{ab'}{r} + \frac{sb''}{r^2} + \frac{tb'''}{r^3} + \&c. + \frac{S}{2bc} \times \overline{\frac{cb'}{r} + \frac{db''}{r^2} + \frac{eb'''}{r^3} + \&c. - \frac{S}{bc} \times \overline{\frac{db'}{r} + \frac{eb''}{r^2} + \frac{fb'''}{r^3} + \&c. + \frac{S}{2bcr} \times \overline{\frac{\overline{d-e} \,.\, b'}{r} + \frac{\overline{e-f} \,.\, \overline{b'+b''}}{r^2} + \&c.}}}}}}}}}}}}}}}}$$

Let y represent the difference between the ages of A and of the oldest person in the table, let K′, C′, B′, T′, B′C′, B′K′,

and B′T′, respectively denote the values of annuities on those single and joint lives for y years, then will the first and second series be $= \frac{2a \cdot \overline{HC-HBC}}{3a} - \frac{d}{6cr} \times \overline{AT-ATB}$, the third series $= \frac{AC-ABC}{3} - \frac{ds}{3acr} \times \overline{NT-NBT} = \frac{ds}{3acr} \times \overline{1+NBT} - \frac{ABC}{3}$, the fourth and fifth series $= \frac{-ax \cdot \overline{HK-HBK}}{6ac} - \frac{AC-ABC}{3r} = \frac{ax \cdot HBK}{6ac} - \frac{1}{6r} + \frac{ABC}{3r} - \frac{AC}{2r}$, the sixth series $= \frac{-x \cdot \overline{AK-ABK}}{3c} + \frac{s \cdot \overline{NC-NBC}}{3ar}$, the seventh series $= \frac{\overline{r-1} \cdot \overline{V-B'}}{2r}$, the eighth series $= \frac{-a \cdot \overline{H-HB}}{2a} + \frac{A-AB}{2r} = \frac{a \cdot HB}{2a} - \frac{1+AB}{2r}$, the ninth series $= \frac{x \cdot \overline{K'-B'K'}}{2c} - \frac{C'-B'C'}{2r}$, the tenth series $= -\overline{C'-B'C'} + \frac{d}{cr} \times \overline{T'-B'T'}$, and the eleventh series $= \frac{C'-B'C'}{2r} - \frac{d}{2cr} \times \overline{T'-B'T'}$. In order to obtain the value of S after the necessary extinction of the life of A, let π and μ denote the probability that B and C respectively die after A; k, δ, ε, ζ, &c. the number of persons living in the table opposite the age of C at the end of y, $\overline{y+1}$, $\overline{y+2}$, &c. years; p the number of persons living opposite the age of B at the end of y years; and β', β'', β''', &c. the decrements of life at the age of B after $\overline{y+1}$, $\overline{y+2}$, $\overline{y+3}$, &c. years. In the $\overline{y+1}$st year the given sum may be received, provided either of three events shall have happened. 1st, If B and C shall have both died in that year. 2dly, If C only shall have died, B having died after A in the first y years. 3dly, If B only shall have died, C having died after A in the first y years. The value of S depending on these contingencies will be $= \frac{S}{r^y} \times \frac{\beta \cdot \overline{k-\delta}}{bcr} + \frac{S \cdot \pi \cdot \overline{k-\delta}}{cr^{y+1}} + \frac{S \cdot \mu \cdot \beta'}{br^{y+1}}$. In the $\overline{y+2}$d,

$\overline{y+3}$d, &c. years, the given sum may be received, provided either of five events shall have happened. 1st, If both the lives of B and C shall have become extinct in the year. 2dly, If C only shall have failed, B having died after A in the first y years. 3dly, If B only shall have failed, C having died after A in the first y years. 4thly, If B shall have failed, C having died in any of the preceding years after the first y years: and 5thly, If C shall have failed, B having died in any of the preceding years after the first y years. The series therefore expressing the value of S after the necessary extinction of A's life will be $\frac{S}{bcr^y} \times \overline{\frac{k-\delta \cdot \beta'}{r} + \frac{\delta-\varepsilon \cdot \beta''}{r^2} + \frac{\varepsilon-\zeta \cdot \beta'''}{r^3} + \&c.} + \frac{S \cdot \pi}{cr^y} \times \overline{\frac{k-\delta}{r} + \frac{\delta-\varepsilon}{r^2} + \frac{\varepsilon-\zeta}{r^3} + \&c.} + \frac{S \cdot \mu}{br^y} \times \overline{\frac{\beta'}{r} + \frac{\beta''}{r^2} + \frac{\beta'''}{r^3} + \&c.} + \frac{S}{bcr^y} \times \overline{\frac{\delta-\varepsilon \cdot \beta'}{r^2} + \frac{\varepsilon-\zeta \cdot \beta'+\beta''}{r^3} + \&c.} + \frac{S}{bcr^y} \times \overline{\frac{k-\delta \cdot \beta''}{r^2} + \frac{k-\varepsilon \cdot \beta'''}{r^3} + \&c.}$

$= \frac{S \cdot \pi}{cr^y} \times \overline{\frac{k-\delta}{r} + \frac{\delta-\varepsilon}{r^2} + \&c.} + \frac{S\mu}{br^y} \times \overline{\frac{\beta'}{r} + \frac{\beta''}{r^2} + \frac{\beta'''}{r^3} + \&c.} + \frac{Sk}{cr^y} \times \overline{\frac{\beta'}{r} + \frac{\beta''}{r^2} + \frac{\beta'''}{r^3} + \&c.} - \frac{S}{bcr^y} \times \overline{\frac{\delta\beta'}{r} + \frac{\varepsilon\beta''}{r^2} + \frac{\zeta\beta'''}{r^3} + \&c.} + \frac{S}{bcr^y} \times \overline{\frac{\delta-\varepsilon \cdot \beta'}{r^2} + \frac{\varepsilon-\zeta \cdot \beta'+\beta''}{r^3} + \&c.}$ The three first of these series are $= \frac{S \cdot \pi k \cdot \overline{r-1} \cdot \overline{V-C^y}}{cr^{y+1}} + \frac{Sp \cdot \overline{r-1}}{br^{y+1}} \times \overline{\mu + \frac{k}{c} \times \overline{V-B^y}}$, supposing C^y and B^y respectively to be the values of annuities on the single lives of persons y years older than C and B. The other two series are a continuation of the tenth and eleventh series in the former part of this solution, so that the sum of those four series will be $= \frac{d}{cr} \times \overline{T-BT} - \overline{C-BC} + \frac{C-BC}{r} - \frac{d}{cr} \times \overline{T-BT} - \frac{C'-B'C'}{2r} + \frac{d \cdot \overline{T'-B'1'}}{2cr} = \frac{d}{2cr} \times \overline{T'-B'T'} - \frac{C'-B'C'}{2r} -$

$\frac{\overline{r-1}\,.\,\overline{C-BC}}{r}$, and the whole value of the given sum will be $=$

$$\text{S into } \frac{\overline{r-1}\,.\,\overline{V-L}}{3r} + \frac{B'C'-C'}{r} - \frac{\overline{r-1}\,.\,\overline{V+B'+AB+AC}}{2r} + \frac{x}{2c} \times \frac{\overline{a\,.\,HBK}}{3a}$$

$$+ \overline{K'-B'K'} - \frac{2\,.\,\overline{AK-ABK}}{3} + \frac{a}{2a} \times \overline{HB + \frac{4\,.\,\overline{HC-HBC}}{3}} + \frac{s}{3ar}$$

$$\times \overline{NC-NBC} + \frac{d}{2cr} \times \overline{T'-B'T' + \frac{2s\,.\,\overline{1+NBT}}{3c} - \frac{AT-ABT}{3}} +$$

$$\frac{\pi\,.\,k\,.\,\overline{r-1}\,.}{cr^{y+1}} \times \overline{V-C^y} + \overline{\mu + \frac{k}{c}} \times \frac{p\,.\,\overline{r-1}}{br^{y+1}} \times \overline{V-B^y}.$$

If *the three lives be equal,* the two first rules become S into

$$\frac{\overline{r-1}\,.\,\overline{V-L}}{3r} + \frac{d}{cr} \times \overline{1 + \frac{2CT+CCT}{3}} - \frac{2dd}{3ccr} \times \overline{1+CTT} - \frac{xx}{3cc} \times$$

$CKK - \frac{2x}{3c} \times \overline{CK-CCK}$, and the last rule becomes S into

$$\frac{\overline{r-1}\,.\,\overline{V-L}}{3r} + \frac{xx\,.\,CKK}{6cc} + \frac{x}{3c} \times \overline{CK-CCK} - \frac{d}{3cr} \times CT - \frac{d}{6cr}$$

$\times CCT - \frac{d}{2cr} + \frac{dd}{3ccr} \times \overline{1+CTT}$. If all the expressions, except the first, in these rules be resolved into their respective series, they will be found to destroy each other, and the general rule in both cases will become simply $= \frac{S\,.\,\overline{r-1}\,.\,\overline{V-L}}{3r}$, which is known from self-evident principles to express the true value in this particular case. The same general rule may also be obtained immediately from the series which denote the value of S in each year, for in the first year its value will in this case be $= \frac{S\,.\,\overline{c-d}\,|^3}{3c^3r}$, in the second year $= \frac{S\,.\,\overline{d-e}\,|^3}{3c^3r^2} + \frac{S\,.\,\overline{c-d}\,.\,\overline{d-e}\,|^2}{c^3r^2}$

$$+ \frac{S\,.\,\overline{c-d}\,|^2\,.\,\overline{d-e}}{c^3r^2}, \text{ in the third year} = \frac{S\,.\,\overline{e-f}\,|^3}{3c^3r^3} + \frac{S\,.\,\overline{c-e}\,.\,\overline{e-f}\,|^2}{c^3r^3} +$$

$\frac{S\,.\,\overline{c-e}\,|^2\,.\,\overline{e-f}}{c^3r^3}$, and so on; hence the whole value will be $=$

$$\frac{S}{3r} - \frac{S}{c} \times \overline{\frac{d}{r} + \frac{e}{r^2} + \frac{f}{r^3} + \&c.} + \frac{S}{cc} \times \overline{\frac{dd}{r} + \frac{ee}{r^2} + \frac{ff}{r^3} + \&c.} - \frac{S}{c^3}$$

$$\times \overline{\frac{d^3}{r} + \frac{e^3}{r^2} + \frac{f^3}{r^3} + \&c.} + \frac{S}{cr} \times \overline{\frac{d}{r} + \frac{e}{r^2} + \frac{f}{r^3} + \&c.} - \frac{S}{ccr} \times$$

$$\overline{\frac{dd}{r} + \frac{ee}{r^2} + \frac{ff}{r^3} + \&c.} + \frac{S}{c^3 r} \times \overline{\frac{d^3}{r} + \frac{e^3}{r^2} + \frac{f^3}{r^3} + \&c.} = \frac{S \cdot \overline{r-1}}{3r} \times$$

$$\overline{V-L}.Q.E.D.$$

PROBLEM VI.

To find the value of a given sum payable on the death of C, provided A should be the first, B the second, and C the third that shall fail of the three lives A, B, and C.

SOLUTION.

When C is the oldest of the three lives. To receive the given sum in the first year, it is only necessary that the three lives should become extinct in the order specified in this problem, and therefore the value of S for this year will be $= \frac{S \cdot \overline{b-m} \cdot \overline{c-d} \cdot a'}{6abcr}$. In the second year the given sum may be received, provided either of three events shall take place; 1st, That all the lives fail in the order required by the problem. 2dly, That B dies after A in the first year, and C dies in the second year. 3dly, That A only dies in the first year, and C dies after B in the second year. Hence the value of S for this year will be $= \frac{S \cdot \overline{m-n} \cdot \overline{d-e} \cdot a''}{6abcr^2} + \frac{S \cdot \overline{b-m} \cdot \overline{d-e} \cdot a'}{2abcr^2} + \frac{S \cdot \overline{m-n} \cdot \overline{d-e} \cdot a'}{2abcr^2}$. To receive the given sum in the third year either of the same events must take place. 1st, The three lives must drop in the order stated above; or 2dly, B must die after A in the first or second year, and C die in the third year; or

3dly, A must die in the first or second year, and C die after B in the third year. The value therefore of S for this year will be $= \frac{S \cdot \overline{n-o} \cdot \overline{e-f} \cdot a'''}{6abcr^3} + \frac{S \cdot \overline{b-n} \cdot \overline{e-f} \cdot \overline{a'+a''}}{2abcr^3} + \frac{S \cdot \overline{n-o} \cdot \overline{e-f} \cdot \overline{a'+a''}}{2abcr^3}$.

By pursuing the same steps during C's life, the whole value may be found $= \frac{S}{6abc} \times \overline{\frac{a'bc}{r} + \frac{a''md}{r^2} + \frac{a'''ne}{r^3} + \&c.} - \frac{S}{6abc} \times \overline{\frac{a'me}{r} + \frac{a''nd}{r^2} + \frac{a'''oe}{a^3} + \&c.} - \frac{S}{2abcr} \times \overline{\frac{nd \cdot a'}{r} + \frac{oe \cdot \overline{a'+a''}}{r^2} + \&c.} - \frac{S}{6abc} \times \overline{\frac{a'bd}{r} + \frac{a''me}{r^2} + \frac{a'''nf}{r^3} + \&c.} + \frac{S}{6abc} \times \overline{\frac{a'md}{r} + \frac{a''ne}{r^2} + \frac{a'''of}{r^3} + \&c.} + \frac{S}{2abcr} \times \overline{\frac{ne \cdot a'}{r} + \frac{of \cdot \overline{a'+a''}}{r^2} + \&c.} + \frac{S}{2acr} \times \overline{\frac{d-e \cdot a'}{r} + \frac{\overline{e-f} \cdot \overline{a'+a''}}{r^2} + \&c.} = S \text{ into } \frac{x}{6c} \times \overline{\frac{\beta \cdot FK - AFK}{b} - \overline{BK - ABK} + \frac{\overline{r-1} \cdot \overline{BC - ABC}}{6r} + \frac{m}{3br} \times \overline{\frac{d \cdot \overline{PT - APT}}{c} - \overline{PC - APC}} - \frac{\beta \cdot \overline{FC - AFC}}{6b} + \frac{C - AC}{2r} + \frac{d}{2cr} \times \overline{\frac{BT - ABT}{3} - \overline{T - AT}}}$.

When B is the oldest of the three lives, it is evident that none of the foregoing series ought to be continued beyond the extinction of B's life, and that after this period the payment of the given sum will depend simply upon the failure of C's life in each of the remaining years, A having previously been survived by B. Let the difference between the age of B and of the oldest person in the table of observations be denoted by x, the probability that B dies after A by π, the value of an annuity on the life of a person x years older than C by C^x, the number of living at this age by k, and the values of annuities on the single and joint lives of A, C, and T for x years by C′, T′, A′C′ and A′T′, then will the required value in this case be $=$

S into $\frac{x}{6c} \times \overline{\frac{\beta \cdot FK - AFK}{b} - \overline{BK - ABK} + \frac{\overline{r-1} \cdot \overline{BC - ABC}}{6r} + \frac{m}{3br}}$

$$\times \overline{\frac{d \cdot \overline{PT - APT}}{c} - \overline{PC - APC} - \frac{\beta \cdot \overline{FC - AFC}}{6b} + \frac{C' - A'C'}{2r} + \frac{d}{2rc} \times \overline{\frac{BT - ABT}{3} - \overline{\Gamma' - A'\Gamma'} + \frac{\pi k \cdot \overline{r-1}}{cr^{x+1}} \times \overline{V - C^x}}}.$$

When A is the oldest and B the youngest of the three lives, let the symbols be changed which denote the decrements and probabilities of life of A and B; let z be the difference between the age of A, and the oldest person in the table, and the whole value of the given sum during the life of A will be $= \frac{S}{2bc} \times$

$$\overline{\frac{cb'}{r} + \frac{db''}{r^2} + \frac{eb'''}{r^3} + \ldots . (z)} + \frac{S}{2bcr} \times \overline{\frac{db'}{r} + \frac{e \cdot \overline{b' + b''}}{r^2} + \ldots . (z)} - \frac{S}{2bc} \times \overline{\frac{db'}{r} + \frac{eb''}{r^2} + \frac{fb'''}{r^3} + \ldots . (z)} - \frac{S}{2bcr} \times \overline{\frac{eb'}{r} + \frac{f \cdot \overline{b' + b''}}{r^2} + \ldots . (z)} - \frac{S}{3abc} \times \overline{\frac{acb'}{r} + \frac{sdb''}{r^2} + \frac{te.b'''}{r^3} + \&c.} - \frac{S}{2abcr} \times \overline{\frac{sd.b'}{r} + \frac{te \cdot \overline{b' + b''}}{r^2} + \&c.} + \frac{S}{3abc} \times \overline{\frac{adb'}{r} + \frac{se.b''}{r^2} + \frac{tf.b'''}{r^3} + \&c.} + \frac{S}{2abcr} \times \overline{\frac{seb'}{r} + \frac{tf \cdot \overline{b' + b''}}{r^2} + \&c.} - \frac{S}{6abc} \times \overline{\frac{scb'}{r} + \frac{td.b''}{r^2} + \frac{ue \cdot b'''}{r^3} + \&c.} + \frac{S}{6abc} \times \overline{\frac{dsb'}{r} + \frac{et.b''}{r^2} + \frac{fu \cdot b'''}{r^3} + \&c.}$$

Let k, δ, ε, ζ, &c. denote the number of persons living opposite the age of C in the table at the end of z, $\overline{z+1}$, $\overline{z+2}$, &c. years, β', β'', β''', &c. the decrements of life opposite the age of B at the end of those years respectively, π the probability that B dies after A, and C^z the value of an annuity on a life z years older than C; then will the value of S in the $\overline{z+1}$st year (depending on the contingency of C's dying after B in that year, or of C's dying in that year, B having died after A in either of the foregoing z years) be expressed by $\frac{S \cdot \overline{k-\delta} \cdot \beta}{2bcr^{x+1}} + \frac{\pi \cdot S \cdot \overline{k-\delta}}{cr^{x+1}}$. In the $\overline{z+2}$d, $\overline{z+3}$d, &c. years, the payment of S will depend upon either

of three events: 1st, Of C's dying after B in that particular year. 2dly, Of C only dying in that year, B having died in either of the preceding $\overline{z+1}$, $\overline{z+2}$, &c. years: or, 3dly, Of C only dying in the year, B having died after A in the first z years. Hence the whole value of S, after the necessary extinction of the life of A by the table, will be $= \frac{S}{2bcr^z} \times \overline{\frac{k-\delta \cdot \beta'}{r} + \frac{\delta-\varepsilon \cdot \beta''}{r^2} + \frac{\varepsilon-\zeta \cdot \beta'''}{r^3} + \&c.} + \frac{S}{bcr^{z+1}} \times \overline{\frac{\delta-\varepsilon \cdot \beta'}{r} + \frac{\varepsilon-\zeta \cdot \beta'+\beta''}{r^2} + \&c.} + \frac{S \cdot \pi}{cr^z} \times \overline{\frac{k-\delta}{r} + \frac{\delta-\varepsilon}{r^2} + \frac{\varepsilon-\zeta}{r^3} + \&c.}$ The last of these series is $= \frac{S \cdot \pi \cdot k \cdot \overline{r-1}}{cr^{z+1}} \times \overline{V - C^z}$; the other two series being added to the four first series in this solution, their sum will be found $= \frac{\overline{r-1} \cdot \overline{V-C+BC}}{2r} + \frac{B'C'}{2r} - \frac{x \cdot BK}{2c} + \frac{d}{2cr} \times \overline{T' - B'T' + 1 - BT}$ (T', B'T', and B'C' denoting the values of annuities on those single and joint lives respectively for z years.) The fifth and sixth series in the solution are $= \frac{\alpha x \cdot HBK}{3ac} - \frac{AC}{2r} - \frac{\overline{r-1} \cdot 2V-ABC}{6r}$, the seventh and eighth series are $= \frac{\alpha \cdot \overline{HC - HBC}}{3a} + \frac{d}{6cr} \times \overline{AT - ABT}$, the ninth is $= \frac{s}{6ar} \times \overline{NC - NBC} - \frac{x}{6c} \times \overline{AK - ABK}$, and the tenth is $= \frac{ds}{6acr} \times \overline{1 + NTB} - \frac{ABC}{6}$. Hence the whole value of the given sum in this case is $= S$ into $\frac{\overline{r-1} \cdot \overline{V-L}}{6r} + \frac{B'C' - \overline{AC+C'}}{2r} - \frac{x}{2c} \times \overline{BK + \frac{AK - ABK}{3}} + \frac{d}{2cr} \times \overline{\frac{AT - ABT}{3} + 1 + T' - BT + B'T'} + \frac{s}{6ar} \times \overline{NC - NBC} + \frac{d \cdot \overline{1+NBT}}{c} + \frac{\alpha}{3a} \times \overline{HC - HBC} + \frac{x \cdot HBK}{c} + \frac{\pi k \cdot \overline{r-1}}{cr^{z+1}} \times \overline{V - C^z}$.

When A is the oldest and C the youngest of the three lives, the

symbols c', c'', c''', &c. must be substituted for $\overline{c-d}$, $\overline{d-e}$, $\overline{e-f}$, &c. and the symbols $\overline{b-m}$, $\overline{m-n}$, $\overline{n-o}$, &c. for b', b'', b''', &c. and the value of the given sum for the first z years, or during A's life, will be $= \frac{S}{6abc} \times \overline{\frac{abc'}{r} + \frac{smc''}{r^2} + \frac{tnc'''}{r^3} + \&c.} - \frac{S}{6abc} \times \overline{\frac{bsc'}{r} + \frac{mtc''}{r^2} + \frac{nu \cdot c'''}{r^3} + \&c.} + \frac{S}{3abc} \times \overline{\frac{amc'}{r} + \frac{snc''}{r^2} + \frac{toc'''}{r^3} + \&c.} + \frac{S}{6abc} \times \overline{\frac{msc'}{r} + \frac{ntc''}{r^2} + \frac{ouc'''}{r^3} + \&c.} + \frac{S}{2c} \times \overline{\frac{c'}{r} + \frac{c''}{r^2} + \frac{c'''}{r^3} + \ldots . (z)} - \frac{S}{2ac} \times \overline{\frac{ac'}{r} + \frac{sc''}{r^2} + \frac{tc'''}{r^3} + \&c.} - \frac{S}{2bc} \times \overline{\frac{mc'}{r} + \frac{nc''}{r^2} + \frac{oc'''}{r^3} + \&c. \ldots . (z)}$. Let p, μ, ν, ξ, &c. represent the number of persons living in the table opposite the age of B at the end of z, $\overline{z+1}$, $\overline{z+2}$, &c. years, and x', x'', x''', &c. the decrements of life opposite the age of C at the end of those years respectively; then, by reasoning as in the foregoing case, the value of S after the necessary extinction of the life of A will be $= \frac{S}{2bcr^z} \times \overline{\frac{\overline{p-\mu} \cdot x'}{r} + \frac{\overline{\mu-\nu} \cdot x''}{r^2} + \frac{\overline{\nu-\xi} \cdot x'''}{r^3} + \&c.} + \frac{S}{bcr^{z+1}} \times \overline{\frac{\overline{p-\mu} \cdot x''}{r} + \frac{\overline{\mu-\nu} \cdot x'''}{r^2} + \frac{\overline{\nu-\xi} \cdot x''''}{r^3} + \&c.} + \frac{S \cdot \pi \cdot}{cr^z} \times \overline{\frac{x'}{r} + \frac{x''}{r^2} + \frac{x'''}{r^3} + \&c.}$

This last series is $= \frac{S \cdot \pi \cdot k \cdot \overline{r-1}}{cr^{z+1}} \times \overline{V - C^z}$. The other two series may be resolved into $\frac{S \cdot p}{cbr^z} \times \overline{\frac{x'}{r} + \frac{x''}{r^2} + \frac{x'''}{r^3} + \&c.} - \frac{S}{2bcr^z} \times \overline{\frac{px'}{r} + \frac{\mu x''}{r^2} + \frac{\nu x'''}{r^3} + \&c.} - \frac{S}{2bcr^z} \times \overline{\frac{\mu x'}{r} + \frac{\nu x''}{r^2} + \frac{\xi x'''}{r^3} + \&c.}$ The first of these is $= \frac{S \cdot p \cdot \overline{r-1}}{br^{z+1}} \times \overline{V - C^z}$; the second (supposing $F'C'$ to denote the value of the joint lives of F and C for z years) is $= \frac{\beta \cdot \overline{FC - F'C'}}{2b} - \frac{\overline{BC - B'C'}}{2r}$; the third is a continuation of the seventh series in this solution, and therefore the whole

of that series is $= \frac{BC}{2} - \frac{m \cdot \overline{1+PC}}{2br}$ . . . The first series in this solution is $= \frac{1+ABC}{6r} - \frac{\alpha\beta \cdot HFC}{6ab}$, the second is $= \frac{s}{6ar} \times \overline{NB - NBC} - \frac{\beta \cdot \overline{AF - AFC}}{6b}$, the third is $= \frac{\alpha}{3a} \times \overline{HB - HBC} - \frac{m \cdot \overline{AP - APC}}{3br}$, the fourth is $= \frac{ms}{6abr} \times \overline{1 + NPC} - \frac{ABC}{6}$, the fifth is $= \frac{\overline{r-1} \cdot \overline{V - C'}}{2r}$, and the sixth is $= \frac{\alpha \cdot HC}{2a} - \frac{1+AC}{2r}$. The whole value therefore of the given sum may be found $= S$. into $\frac{\overline{r-1}}{6r} \times \overline{V - 3C' + 3BC - ABC} + \frac{BC' - AC}{2r} + \frac{\beta}{2b} \times \overline{FC - F'C' - \frac{AF - AFC}{3} - \frac{\alpha \cdot HFC}{3a}} + \frac{\alpha}{2a} \times \overline{\frac{2 \cdot \overline{HB - HBC}}{3} + HC} + \frac{s}{6ar} \times \overline{NB - NBC + \frac{m \cdot \overline{1+NPC}}{b}} - \frac{m}{2br} \times \overline{1 + PC + \frac{2 \cdot \overline{AP - APC}}{3}} + \overline{\pi + \frac{p}{b} \times \frac{k \cdot \overline{r-1}}{cr^{z+1}}} \times \overline{V - C^z}$.

When the lives are all equal, the expression $\frac{\beta x \cdot FK}{6bc}$ in the first and second rules becomes $= \frac{1+CC}{6r}$, the expression $\frac{md \cdot PT}{3ccr}$ becomes $= \frac{CC}{3} - \frac{dd}{3ccr}$, and the expression $\frac{C}{2r} - \frac{d \cdot T}{2cr}$, or $\frac{C'}{2r} - \frac{dT'}{2cr}$ becomes $= \frac{d}{2cr} - \frac{\overline{r-1} \cdot C}{2r}$, so that those rules become $= S$ into $\frac{\overline{r-1} \cdot \overline{V-L}}{6r} - \frac{x}{3c} \times \overline{CK - CCK} + \frac{d}{2cr} \times \overline{1 + \frac{CCT}{3}} - \frac{xx \cdot CKK}{6cc} - \frac{dd}{3ccr} \times \overline{1 + CTT}$. In the third rule the expressions $\frac{d}{2cr} \times \overline{T' - B'T'} - \frac{C' - B'C'}{2r}$ become $= \frac{CC}{2r} - \frac{d}{2cr} \times \overline{1 - CT}$, so that in this case the value is $= S$ into $\frac{\overline{r-1} \cdot \overline{V-L}}{6r} + \frac{d}{3cr} \times \overline{CT - CCT} - \frac{x}{3c} \times \overline{CK + \frac{CCK}{2}} + \frac{xx \cdot CKK}{3cc} + \frac{dd}{6ccr} \times \overline{1 + CTT}$,

and by the fourth rule it becomes = S into $\frac{\overline{r-1}.\overline{V-L}}{6r} + \frac{x}{3c} \times \overline{2CK - \frac{CCK}{2} - \frac{xx.CKK}{6cc} - \frac{d}{2cr} - \frac{d}{3cr}} \times \overline{2CT - \frac{CCT}{2} + \frac{dd}{6ccr}} \times \overline{1 + CTT}$. If the values of the joint lives in each of those rules be resolved into their respective series, all the expressions, except the first, will be found to destroy each other, and the general rule in all of them will become simply $= \frac{S.\overline{r-1}.\overline{V-L}}{6r}$, which from self-evident principles in this particular case, is known to be the true value. A similar result may likewise be immediately obtained from the series themselves; for the value of S for the first year is easily found in this case to be $= \frac{S}{r} \times \overline{\frac{1}{6} - \frac{d}{2c} + \frac{dd}{2cc} - \frac{d^3}{6c^3}}$, for the second year $= \frac{S}{r^2} \times \overline{\frac{ee}{2cc} - \frac{dd}{2cc} + \frac{d}{2c} - \frac{e}{2c} + \frac{d^3}{2c^3} - \frac{e^3}{2c^3}}$, for the third year $= \frac{S}{r^3} \times \overline{\frac{ff}{2cc} - \frac{ee}{2cc} + \frac{e}{2c} - \frac{f}{2c} + \frac{e^3}{2c^3} - \frac{f^3}{2c^3}}$, and so on for the other years. Hence the whole value is $= \frac{S.\overline{r-1}.\overline{V-L}}{6r}$ . . . . . Q. E. D.

It is to be observed, that the fractions $\frac{\overline{b-m}.\overline{d-e}.d'}{2abcr^2}$, $\frac{\overline{b-n}\ \overline{e-f}\ \overline{a'+a''}}{2abcr^3}$, &c. do not accurately express the value of S on the second contingency in this problem; but that according to the lemma they should have been $\frac{\overline{b-n}.\overline{d-e}.a'}{2abcr^2}$, $\frac{\overline{\overline{b-n}.a' + \overline{m-n}.\overline{a'+a''}} \times \overline{e-f}}{2abcr^3}$, &c. In order to determine how near the former * approach to the

* When B is the oldest these fractions are $= \frac{C' - A'C' - BC + ABC}{2r} + \frac{d}{2cr} \times \overline{\overline{BT - ABT} - \overline{T' - A'T'}}$. When A is the oldest they are $= \frac{C' - B'C' - AC + ABC}{2r} + \frac{d}{2cr} \times \overline{\overline{AT - ABT} - \overline{T - B'T'}}$.

true values, I have in the following examples undergone the labour of separately computing each of those latter fractions, and the results appear to differ so little from the approximated values, that I think a greater degree of accuracy need not be required.

Value of £ 100, *payable on the contingency in this problem, computed from the Northampton table, at* 4 per cent.

Ages of A.	B.	C.	Value by the rule.	Correct value.	Difference.
10	85	80	1.467	1.438	0.029
15	75	73	2.233	2.150	0.083
15	75	35	2.761	2.589	0.172
15	75	78	1.698	1.513	0.185
20	65	64	3.031	2.912	0.119
20	65	70	2.588	2.580	0.008
70	80	78	9.457	9.068	0.389
70	80	35	10.109	9.618	0.491

I have chosen those cases in which the approximation was likely to have been most inaccurate; for if the ages of A and B are either both younger, or differ less from each other than they do in these examples, it is obvious that the foregoing rules must be still nearer the truth. I have also uniformly supposed the life of B to be older than that of A, and of consequence the approximated value always errs in excess; if the life of A had been the older of the two, it would have been found to have erred in defect, and nearly to the same amount. But as, in this latter case, the value of the reversion is greater

than when B is the older life, the error must necessarily bear a less proportion to the whole value than it does in the preceding examples.

With regard to the fifth problem, the error in some cases is greater, in others less than in the present problem. If B and C are both older than A it will be nearly twice as great. If one is older and the other younger, it will be altogether inconsiderable; for the fractions which express the probability of the older of B and C dying after A will be as much above the truth, as the other fractions expressing the probability that the younger of these two lives die after A will be below it, and thus the errors of one correct those of the other, and render the computation almost perfectly accurate. I have not given any examples to that problem, not only as the correctness of its rules may be inferred from the examples which have been given to those of the present problem, but as I wished to make as few additions as possible to a paper, which having engaged a large portion of my time and attention for the last three years, has already become too long, and for which my only apology is the attempt to give correct, and not very laborious, solutions to some of the most difficult and complicated cases in the doctrine of survivorships.

XVIII. *Observation of the great Eclipse of the Sun of Sept. 5, 1793. By* John Jerome Schroeter, *Esq. Communicated by* George Best, *Esq. F. R. S.*

Read May 15, 1794.

Although the weather, owing to temporary clouds and flying showers, have at times been somewhat unfavourable, it was yet upon the whole sufficiently clear to admit of a good observation, to which the superiority of my instruments was not a little conducive.

Having prepared my hand telescope, being a 7-feet reflector, with a power magnifying 50 times with great distinctness, and with a field that took in more than the disk of the sun, I watched attentively for the first contact, but was prevented by some intervening clouds: the first glimpse, however, I had was immediately after the immersion, which took place at the north-west edge of the sun; and it was as yet so very trifling, that had it not been for the excellence of my instruments I should hardly have perceived it; and I am well assured that the first contact did not take place above 4 seconds before this instant of time. This observation was, according to true time, (corrected by 9 equal altitudes on the 4th and 6th) on the 5th Sept. at $10^h\ 26'\ 59'',3$; so that the first contact must have been at $10^h\ 26'\ 55''$. The distance of the cusps I could not observe.

The end of the eclipse was, on the other hand, observed with

much more accuracy; for although the sun was at this time frequently covered by clouds of different densities, yet by means of a variety of glasses, which I applied occasionally to the eye-glass of my telescope, I was enabled to see distinctly the decreasing obscuration, which during the 3 last seconds was scarcely perceptible, although certainly still existing, the orb of the sun not being perfectly complete till after the expiration of the last-mentioned interval, which ended at $1^h\ 32'\ 54''$ true time. All these observations were made with the abovementioned 7-feet telescope, made by professor SCHRADER, magnifying 50 times.

During the intermediate period of the eclipse, the atmosphere being tolerably serene, I was enabled by the excellence of this telescope, and a large 13-feet reflector, to make a very interesting observation, which led to some important inferences.

1. All my telescopes, even the 3-feet achromatic, applied to my quadrant, shewed the globular body of the moon like a dusky grey orb floating before the sun, its faint light becoming somewhat brighter towards the rim.

2. Both myself, and several other persons who were then with me, perceived soon after the beginning of the eclipse three high ridges of mountains on the south-east border of the moon projecting sensibly into the disk of the sun; one of them appearing to be a long and considerable mountainous range, and the two others to the westward being more in the shape of prominent points. This was seen with the 7-feet reflector magnifying only 50 times, but this very distinctly: I applied a power of 160, together with the projection machine, and found that the two last-mentioned points were from 24 to 28 seconds asunder; that the long eastern range was somewhat

more distant from the nearest of the former, and that all of them projected, if not 4, at least 3 seconds beyond the rim of the moon; so that their height from the said rim could not be less than three-quarters of a German mile. It occurred to me that these probably were parts of the very high mountainous region *Doerfel* (*v.* Selen. Fragm. Tab. IV.); I delineated them, and compared them with my charts, and found that, though according to the present libration of the moon their projection ought not to be precisely as here represented, the coincidence was yet sufficiently striking.

Soon after, when the south-western limb of the moon had advanced a little further on the disk of the sun, I discovered on this part another equally prominent mountainous range, which I also measured and delineated. It consisted of a ridge one minute and from 30 to 40 seconds, and therefore not less than 23 or 24 geographical miles, in length; and four insulated mountains to the westward, all projecting from 2 to 3 seconds beyond the rim of the moon; these I had little doubt must be parts of the very lofty mountainous region *Leibnitz*, which a particular libration now presented in such a projection to our sight.

About noon, the eclipse being then at its greatest obscuration, I ventured to direct my excellent 13-feet reflector to the dim light of the sun; and now the dark orb of the moon, and its lofty mountainous rim to the southward, appeared with such uncommon, and in a manner palpable distinctness, that the impression of it can never be effaced from my imagination. I at the same time distinguished between these high ridges, other less ones, which however were equally well defined, but which I had not perceived with the 7-feet reflector; and

the contrast between several lofty ridges, and the smooth almost regular rim of the moon to the westward, was here sufficiently striking.

3. Not having for several days before, and likewise on the very day of the eclipse, noticed any spots on the disk of the sun, three small ones only excepted, which were perceived on the 29th of August; and it appearing very remarkable to me that, with this particular modification of the atmosphere of the sun, none of its blazing spots should be perceptible; I confess I was not a little surprised on viewing the sun's disk with my large reflector, to find that no, either dark or blazing, spots appeared on the luminous part, but that the whole visible disk was in a manner marbled, or covered over with whitish, more or less faint, nebulosities; as I had indeed seen it some years ago with my 7-feet HERSCHELIAN telescope, but by far not in so striking a degree. I at the same time discovered, westward towards the rim of the sun, a very small but distinct blackish spot, which other observers with inferior telescopes may well not have noticed, since I myself could not see it with my 7-feet SCHRADERIAN reflector. Some other observations I have made I shall reserve for the present.

Lilienthal,
Sept. 8, 1793.

XIX. *Experiments and Observations made with the Doubler of Electricity, with a view to determine its real Utility, in the investigation of the Electricity of atmospheric Air, in different degrees of Purity.* *By Mr.* John Read. *Communicated by* Richard Henry Alexander Bennet, *Esq. F. R. S.*

Read May 15, 1794.

It is scarcely necessary to observe, that having removed the uncertainty respecting the electrical action of this curious instrument, by demonstrating (after much care and pains, as is particularly expressed in my tract on Spontaneous Electricity) that the electricity of the doubler is alone derived from the common electrified aqueous vapour suspended in the air; I shall, without any further explanation, beg leave here to express my thoughts in terms according to that demonstration.

When I employ the doubler to investigate atmospheric electricity, I use it with its revolving plate uninsulated, when opposite to that fixed plate which is insulated; because, with respect to insulation, that position of the doubler exactly corresponds to the insulated and uninsulated parts of my high pointed rod, and of course their electrical accumulation will always be of the same kind in all weak electrifications of the atmosphere. To avoid repetition, permit me here also to mention, that care has been always taken to *clear* the doubler

of its former electric *charge*, before I proceeded to accumulate another.

Some observations which I made some time ago, induced me to suspect that air, by being vitiated even in a small degree in various ways, as by respiration, putrefaction, &c. lost a portion of its natural electricity, and became thereby electrified negatively: the following facts seem to substantiate this supposition. The room I usually inhabit being of small dimensions, is on that account more liable to suffer a change in the electrical state of its air than a larger one; and having been often struck with the constancy of the doubler charging negatively in it, whereas in the open air, and often in the adjoining room, which is larger, the doubler would give positive electricity; I saw nothing to occasion this difference between the two rooms besides what could be attributed to the respiration and to the usual effluvium of my body. I was therefore curious to try on the 9th of July, 1793, whether a change could be effected in the electrical state of the air in the large room by the same means. The weather being very hot and serene, therm. 75°, I invited a second person to sit with me in this room during the space of 20 or 30 minutes, with the door and windows close shut up; I placed myself nearly in the middle, and my companion at the side of the room. At the end of 20 minutes I was in a profuse perspiration, which according to my ideas must promote the business in hand; I therefore worked the doubler, and found the experiment to succeed agreeably to my expectation, as it now gave negative electricity.

Suspecting that similar effects must take place during sleep in my bed-room, which is on the north side of the house, I

examined the electric state of the air both within and without the bed-room a little before I went to rest, and found it positive by the doubler. I arose at six o'clock next morning, and worked the doubler, and it quickly became electrified negatively. But as it often happens, in completing one discovery we get an imperfect knowledge of others, I was surprised to observe, by the action of the doubler, to what a great degree the air in the room was deprived of its insulating quality; for although the doubler accumulated electricity in every revolution strong enough to enable me to ascertain its kind, yet its electric charge was conducted away almost as quickly as obtained.

With a view to determine what happens in the upper part of the house, I went up into the garret, and found it close shut up, and the air within it was excessively hot, and in some degree noxious; therm. 80°. After a very few turns of the revolving plate, the doubler became electrified negatively: I immediately set the door and windows wide open, and another door which opens over a bow window, to let in fresh air; but the wind blowing moderately strong from the east, and the bow window door being at the north end, and the windows at the south end of the garret, made it unfavourable for an east wind to drive through it, therefore its electric state remained the same in kind after they had been opened, as when shut; for I examined it at several intervals of time: yet the state of the air became thereby considerably better to breathe in. These facts will appear still more extraordinary, when we consider that the general state of atmospheric electricity at the time of performing these experiments was of the positive kind, as appeared by the doubler when placed on the wood hand-rail of the bow window, which is only three

feet and six inches out of the garret. Had the direction of the wind been north or south, it would have passed through the garret with force, and would, no doubt, have changed by regular gradation its electricity to positive; a fact that I have often observed to succeed very quickly.

I likewise observed, that when the excessive heat of the sun was full upon any other room in my house, it was capable of effecting a change in their electrical state, excepting in those which were under ground; for in the two kitchens, open area, and coal-vault, the doubler became electrified positively; in the two former rooms speedily, but in the two latter, that lay more to the sun, slowly. I have observed before, that the air in the garret was infected with a noxious exhalation, which I now judge came from the wearing apparel laid up in it: whereas the air in the kitchens was not only much cooler, but perfectly clear of all offensive exhalations. However, on the 17th of July, the two kitchens were white-washed and painted, and of course were filled with a noxious effluvium. The day after, I worked the doubler in the kitchens, and by a very few turns of the revolving plate it gave negative electricity.

Knightsbridge charity-school fills up a piece of ground between the north end of the chapel and Hyde-Park wall; and the main sewer of that neighbourhood runs at no great depth under it; the number of children educated in this school is thought by some to be too great for the size of the school; on these accounts it becomes infected with a very disagreeable stench, especially when the door and windows are shut up; I have sometimes found the noxious effluvium so very strong in this school, that I have hastened out to breathe a purer air. I have often examined the electrical state of the air in this

school with the doubler, and have always found it strongly negative; which shewed that the aqueous or other conducting matter lodged in the air of the school, possessed less than their natural quantity of electricity; while that of the schoolmaster's parlour adjoining, having nobody in it, possessed somewhat more than its natural quantity, it was found therefore positively electrified.

July 5th, therm. 76°, I went to the school, and found the door and windows set wide open to let in cool air; I now perceived no stench at all in the school, and thought it needless to try it. However the schoolmaster observed that the further end of the school was at all times most infected with, and seldom quite clear of stench. I therefore worked the doubler in that part of it, and after a very few turns it became electrified negatively, rather against my expectation. I then tried the other end of the school, which, by the door being wide open, was less liable to retain any noxious effluvium, and there the doubler gave positive electricity. After this I tried it in the schoolmaster's parlour, where it was positive also.

July 30th, I had the curiosity to examine with the doubler the electrical state of the air in the wards of the Lock Hospital. In the two small men's wards it was found negative in every part. The floor of the large or long ward had been washed, and the boards were still wet; the windows in the east side, and the large one in the south end, were all open; therefore there was but very little offensive smell in the south end of this ward, and here the doubler became electrified positively: but the great window in the north end of this ward being close shut up, caused a sensible closeness in the air, accompanied with a slight smell; and in this end of the ward the doubler

gave negative electricity. The door and all the windows in the women's long ward were set wide open; the open windows at each end of this ward being nearly in the direction of the wind, gave it a complete passage through it; of course, the wind blowing at that time with a brisk gale, ventilated this ward completely, for there was no offensive smell in it; however, I tried the state of the air in several parts of it with the doubler, in all of which it gave positive electricity, the same as it would have done in the open air on the outside of the building.

December 6th, I observed in the garden a heap of the loppings and leaves of shrubs, in a state of putrefaction, which induced me to examine their volatile effluvium with the doubler, which I placed upon the heap, and on working it, it became possessed of a weak negative electricity; for it required more than thirty turns of the revolving plate to effect a good charge, whereas in the privy (which is at a small distance from the heap of leaves) the doubler became strongly charged with less than half that number of turns, and with the same kind of electricity. This, indeed, I expected would have been the case, because I have always observed the doubler to give negative electricity in a privy; but that the rotten leaves should be able to maintain that electric state in the open air, is truly wonderful, when it is considered that the surrounding atmospherical electricity was of the positive kind, and rather strongly so, both by the doubler and the high pointed rod. I am of opinion that I should not have given due attention to this fact, if it had not so happened that the doubler had not been used for near two weeks before; it was therefore evident, that it

must have been wholly deprived of every particle of its former charge.

The day after this, the heap of leaves was laid open, and every twig and leaf exhibited a covering of white mould; but after this, the doubler always gave the same kind of electricity when worked on the leaves, as in any other part of the open air, namely, positive. In order to be fully satisfied in this matter I determined to try it on a large dunghill, whence a greater quantity of putrid effluvium must ascend. I also resolved to make the experiment when the air was sharp and frosty, because then the atmospheric electricity is not only of the positive kind, but uniformly the same in all places, from the surface of uncontaminated earth to any height we can go. The weather on the first day of January, 1794, was quite such as I desired for this business, that is, it was frosty, and accompanied with a very slight dry fog, therm. 31°.

I conjectured that Mr. TATTERSALL (a dealer in horses in my neighbourhood) might be possessed of a large dunghill; I therefore went to his house, and was taken into his garden, where there was a great quantity of it. I first went upon the highest part of the dunghill, and held the doubler in one hand a little above the dung, yet within the reach of the ascending pale coloured vapour, and with the other I turned the revolving plate five or six times, by which means the doubler became electrified positively; which was known to be at that time the general electrical state of the atmosphere. The doubler was now lowered, and placed upon the dung; and here also it became charged by a few turns of the revolving plate, which made me suspect that I had not completely cleared the doubler

of its former charge; however, on trial it was found to be electrified negatively. This remarkable fact fully satisfied me that I had not deceived myself in the first experiment on the heap of leaves above mentioned.

I repeated these experiments, with the doubler placed on various parts of the dunghill, without any remarkable variation in the results, except that the negative state of the exhaled vapour was stronger, and extended to a greater distance, in the depressed or hollow parts of the dung, where the vapour was less exposed to a moderate gale of wind that then prevailed, than on the open parts which lay full to it. I have reason to be of opinion, that the negative state of the vapour on the windward side of the dung did not reach so high as the revolving plate of the doubler when turned up, so that in every revolution it must pass through electrified and neutral vapour, which required in those situations from thirty to forty revolutions to obtain a small charge. From this circumstance I am inclined to think that if a doubler were made of very small dimensions, and placed in the neutral space between the two electric powers, it would be impossible to accumulate with it any spontaneous electricity.

I was solicited to try the state of the air in the hot-house with the doubler, to which I very readily consented. I found the air in it agreeably warm, and full of moisture, which was condensed on the glass roof, and fell down in large drops. The doubler also, having been long exposed in frosty air, quickly attracted and condensed the humid particles upon itself, so as to form a coating on all its parts. I therefore hastened to make the experiment; yet under all these unfavourable circumstances the doubler became electrified negatively after about

fourteen revolutions. As I perceived no smell in this close hot-house, I am inclined to attribute the negative electric state of the vapour to the heat of the fire and vigour of the plants, which possibly may absorb the fluid faster than it could get in through the floor, which is rendered very dry by flues that lie on three sides of it.

Without even attempting to consider in this place how far the influence of electricity is concerned in all sorts of vitiated air, it will be sufficient to remark, as it clearly follows from the preceding experiments, that air infected with animal respiration, or vegetable putrefaction, is always electrified negatively, when at the same time the surrounding atmosphere is electrified positively.

XX. *Tables for reducing the Quantities by Weight, in any Mixture of pure Spirit and Water, to those by Measure; and for determining the Proportion, by Measure, of each of the two Substances in such Mixtures.* By Mr. George Gilpin, *Clerk to the Royal Society.* *Communicated by Sir* Charles Blagden, *Knt. Sec. R. S.*

Read June 19th, 1794.

THESE tables are founded on the experiments of which the results were given in the Report and Supplementary Report on the best method of proportioning the excise on spirituous liquors.* They are computed for every degree of heat from 30° to 80°, and for the addition or subtraction of every one part in a hundred of water or spirit; but as the experiments themselves were made only to every fifth degree of heat, and every five in the hundred of water or spirit, the intermediate places are filled up by interpolation in the usual manner, with allowance for second differences.

Every table consists of eight columns, and there are two tables for every degree of heat. In the first column of the *first* of the two tables, are given the proportions of spirit and water by weight, 100 parts of spirit being taken as the constant number, to which additions are made successively of one part of water from 1 to 99 inclusively. The first column in the *second* table has 100 parts of water for the constant number, with the parts of spirit decreasing successively by unity, from

100 to 1 inclusively. It must be observed, that each of these tables occupying one page, is divided in the middle for adapting it more conveniently to the size of the paper; but the whole of each page is to be considered as one continued table. The second column of all the tables gives the specific gravities of the corresponding mixtures of spirit and water in the first column, taken from the table of specific gravities in the Supplementary Report, the intermediate spaces being filled up by interpolation. In the third column 100 parts by measure of pure spirit, at the temperature marked on the top of every separate table, is assumed as the constant standard number, to which the respective quantities of water by measure, at the same temperature, are to be proportioned in the next column. The fourth column, therefore, contains the proportion of water by measure, to 100 measures of spirit, answering to the proportions by weight in the same horizontal line of the first column. The fifth column shews the number of parts which the quantities of spirit and water contained in the third and fourth columns would measure when the mixture has been completed; that is, the bulk of the whole mixture after the concentration, or mutual penetration, has fully taken place. The sixth column, deduced from the three preceding ones, gives the effect of that concentration, or how much smaller the volume of the whole mixture is, than it would be if there was no such principle as the mutual penetration. The seventh column shews the quantity of pure spirit by measure, at the temperature in the table, contained in 100 measures of the mixture laid down in the fifth column. Lastly, the eighth column gives the decimal multiplier, by means of which the quantity by measure of standard pure spirit, of ,825 specific gravity at

60° of heat, may at once be ascertained, the temperature and specific gravity of the liquor being given; pursuant to the idea suggested in the Report, that "the simplest and most equitable "method of levying the duty on spirituous liquors would be, "to consider rectified spirit as the true and only excisable "matter."

It may be proper to add a short account of the method pursued in computing some of the columns of these tables. Columns I. II. and III. require no other explanation than has been already given. Col. IV. is obtained thus: divide the specific gravity of the pure spirit, at the temperature in the table, by the specific gravity of water at the same temperature: then, for the *first* of the two tables for each degree of heat, the proportion is, as 100 is to the quantity of water by weight in the first column, so is the quotient of the abovementioned division to the quantity of water by measure sought; for the *second* of the two tables the proportion is, as the quantity of spirit by weight in the first column is to 100, so is that same quotient to the quantity of water by measure sought.

Col. V. requires more calculation. The first step is to compute what the specific gravity of the mixture in question would be if no concentration took place; to obtain which, the constant number 100 (indicating the quantity by measure) of pure spirit, is to be multiplied by the specific gravity of pure spirit at the temperature in the table, and the corresponding measure of water in the fourth column is also to be multiplied by its specific gravity at the given temperature; these two products being added together, their sum is to be divided by the sum of the absolute quantities of spirit and water by measure in the same horizontal line of the third and fourth columns:

then the proportion is, as this quotient (or what the specific gravity would be without concentration) is to the real specific gravity as found in the same horizontal line of the second column of the table, so is the sum of the quantities of spirit and water in the third and fourth columns inversely to the bulk of the mixture.

Col. VI. is obtained by subtracting the real bulk of the mixture in col. V. from the sum of the quantities of spirit and water in col. III. and IV. the difference between them being the diminution occasioned by the concentration on that whole quantity. Col. VII. is obviously to be computed by the following proportion: as the bulk of the whole quantity of the mixture in col. V. is to 100 (the constant quantity), so is 100 to the quantity of pure spirit *per cent.* at the temperature of the table. Col. VIII. is formed by reducing the volume of the spirit *per cent.* at the temperature of the table, to its volume at 60°, by the following proportion: as ,825 (the specific gravity of pure spirit at 60°) is to its specific gravity at the given temperature, so is the number in the seventh column to the volume of pure spirit, at 60° of heat, contained in 100 parts by measure of the mixture at the temperature of the table: this divided by 100 is the decimal multiplier sought; the product of which into any measure of a spirituous liquor of the corresponding specific gravity and temperature, will be the true quantity of standard pure spirit, at 60° of heat, contained in that liquor.

It may very probably be thought right, for the future use of the revenue, to compute another set of tables, in which the degree of heat standing at the head of each table, the first column of it shall be even numbers of specific gravity. This would be proper for looking out at once the quantities of spirit

and water in a mixture, from its heat and specific gravity, as immediately determined by experiment. For scientific purposes also, tables should be constructed to shew the regular increments and decrements of the concentration, by equal variations in the proportions of spirit and water: but these, and others of a similar nature, which might be suggested, do not belong to the present subject. C. B.

TABLE I. HEAT 30°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83896	100	—	100,00	—	100,00	1,0169
1	,84129	—	0,84	100,72	0,12	99,28	1,0096
2	,84355	—	1,68	101,45	0,23	98,57	1,0024
3	,84575	—	2,51	102,18	0,33	97,87	,9953
4	,84788	—	3,35	102,91	0,44	97,18	,9882
100 + 5	,84995	—	4,19	103,64	0,55	96,49	,9812
6	,85197	—	5,03	104,38	0,65	95,80	,9743
7	,85394	—	5,87	105,12	0,75	95,13	,9674
8	,85586	—	6,71	105,87	0,84	94,46	,9606
9	,85773	—	7,54	106,61	0.93	93,80	,9539
100 + 10	,85957	—	8,38	107,36	1,02	93,14	,9472
11	,86138	—	9,22	108,11	1,11	92,50	,9406
12	,86316	—	10,06	108,86	1,20	91,86	,9341
13	,86490	—	10,90	109,61	1,29	91,23	,9277
14	,86660	—	11,73	110,37	1,36	90,61	,9214
100 + 15	,86825	—	12,57	111,12	1,45	89,99	,9151
16	,86984	—	13,41	111,87	1,54	89,38	,9089
17	,87139	—	14,25	112,63	1,62	88,77	,9028
18	,87291	—	15,09	113,39	1,70	88,17	,8967
19	,87440	—	15,93	114,15	1,78	87,58	,8907
100 + 20	,87585	—	16,77	114,91	1,86	87,00	,8847
21	,87729	—	17,60	115,67	1,93	86,42	,8788
22	,87871	—	18,44	116,44	2,00	85,85	,8730
23	,88010	—	19,28	117,21	2,07	85,29	,8673
24	,88147	—	20,12	117,98	2.14	84,73	,8616
100 + 25	,88282	—	20,96	118,75	2,21	84,18	,8560
26	,88414	—	21,80	119,53	2,27	83,64	,8505
27	,88544	—	22,63	120,31	2,32	83,10	,8451
28	,88672	—	23,47	121,09	2,38	82,57	,8397
29	,88797	—	24,31	121,87	2,44	82,05	,8344
100 + 30	,88921	—	25,15	122,65	2,50	81,53	,8291
31	,89043	—	25,99	123,43	2,56	81,02	,8239
32	,89163	—	26,83	124,21	2,62	80,51	,8188
33	,89281	—	27,66	124,98	2,68	80,01	,8137
34	,89397	—	28,50	125,76	2,74	79,52	,8087
100 + 35	,89511	—	29,34	126,53	2,81	79,03	,8037
36	,89623	—	30,18	127,31	2,87	78,55	,7988
37	89733	—	31,02	128,09	2,93	78,07	,7939
38	,89842	—	31,86	128,87	2,99	77,60	,7891
39	,89949	—	32,69	129,65	3,04	77,13	,7844
100 + 40	,90054	—	33,54	130,43	3,11	76,67	,7797
41	,90158	—	34,38	131,21	3,17	76,21	,7751
42	90260	—	35,22	131,99	3,23	75,76	,7705
43	90361	—	36,05	132,77	3,28	75,32	,7660
44	,90460	—	36,89	133,55	3,34	74,88	,7615
100 + 45	,90558	—	37,72	134,33	3,39	74,44	,7570
46	,90654	—	38,56	135,12	3,44	74,01	,7526
47	,90749	—	39,40	135,90	3,50	73,58	,7483
48	,90842	—	40,24	136,69	3,55	73,16	,7440
49	,90933	—	41,08	137,47	3,61	72,74	,7397

I. Spirit and Water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,91023	100	41,92	138,26	3,66	72,33	,7355
51	,91111	—	42,75	139,04	3,71	71,92	,7314
52	,91197	—	43,59	139,83	3,76	71,51	,7273
53	,91282	—	44,43	140,62	3,81	71,11	,7232
54	,91366	—	45,27	141,41	3,86	70,72	,7191
100 + 55	,91449	—	46,11	142,20	3,91	70,33	,7151
56	,91531	—	46,95	142,99	3,96	69,94	,7112
57	,91612	—	47,78	143,78	4,00	69,55	,7073
58	,91691	—	48,62	144,57	4,05	69,17	,7034
59	,91770	—	49,46	145,36	4,10	68,80	,6996
100 + 60	,91847	—	50,30	146,15	4,15	68,42	,6958
61	,91923	—	51,14	146,94	4,20	68,05	,6920
62	,91998	—	51,98	147,73	4,25	67,69	,6883
63	,92072	—	52,81	148,52	4,29	67,33	,6846
64	,92145	—	53,65	149,32	4,33	66,97	,6810
100 + 65	,92217	—	54,49	150,11	4,38	66,62	,6774
66	,92288	—	55,33	150,90	4,43	66,27	,6739
67	,92358	—	56,17	151,70	4,47	65,92	,6704
68	,92427	—	57,01	152,49	4,52	65,58	,6669
69	,92496	—	57,84	153,29	4,55	65,24	,6634
100 + 70	,92563	—	58,68	154,08	4,00	64,90	,6600
71	,92629	—	59,52	154,88	4,64	64,57	,6566
72	,92694	—	60,36	155,67	4,69	64,24	,6532
73	,92758	—	61,20	156,47	4,73	63,91	,6499
74	,92821	—	62,04	157,26	4,78	63,59	,6466
100 + 75	,92889	—	62,87	158,06	4,81	63,27	,6434
76	,92951	—	63,71	158,85	4,86	62,95	,6402
77	,93012	—	64,55	159,65	4,90	62,63	,6370
78	,93078	—	65,39	160,45	4,94	62,32	,6338
79	,93132	—	66,23	161,25	4,98	62,02	,6306
100 + 80	,93191	—	67,07	162,05	5,02	61,71	,6275
81	,93249	—	67,90	162,84	5,06	61,41	,6244
82	,93306	—	68,74	163,64	5,10	61,11	,6214
83	,93363	—	69,58	164,44	5,14	60,81	,6184
84	,93419	—	70,42	165,24	5,18	60.52	,6154
100 + 85	,93474	—	71,26	166,04	5,22	60,22	,6124
86	,93529	—	72,10	166,84	5,26	59,94	,6095
87	,93583	—	72,93	167,64	5,29	59,65	,6066
88	,93636	—	73,77	168,44	5,33	59,37	,6037
89	,93689	—	74,61	169,24	5,37	59,09	,6008
100 + 90	,93741	—	75,45	170,04	5,41	58,81	,5980
91	,93792	—	76,29	170,85	5,44	58,53	,5952
92	93843	—	77,13	171,65	5,48	58,26	,5924
93	,93893	—	77,96	172,45	5,51	57,99	,5897
94	,93942	—	78,80	173,25	5,55	57,72	,5870
100 + 95	,93991	—	79,64	174,05	5,59	57,45	,5843
96	,94038	—	80,47	174,85	5,62	57,19	,5816
97	,94085	—	81,30	175,65	5,65	56,93	,5790
98	,94131	—	82,14	176,46	5,68	56,67	,5763
99	,94177	—	82,98	177,27	5,71	56,41	,5736

TABLE II. HEAT 30°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,94222	100	83,83	178,08	5,75	56,15	,5710
99	,94267	—	84,69	178,90	5,79	55,89	,5684
98	,94312	—	85,55	179,74	5,81	55,63	,5658
97	,94357	—	86,43	180,59	5,84	55,37	,5631
96	,94402	—	87,33	181,45	5,88	55,11	,5604
100 + 95	,94447	—	88,25	182,33	5,92	54,84	,5577
94	,94492	—	89,18	183,24	5,94	54,57	,5550
93	,94537	—	90,14	184,17	5,97	54,30	,5522
92	,94583	—	91,12	185,12	6,00	54,02	,5494
91	,94629	—	92,13	186,09	6,04	53,74	,5465
100 + 90	,94675	—	93,15	187,08	6,07	53,45	,5436
89	,94723	—	94,19	188,09	6,10	53,17	,5407
88	,94771	—	95,26	189,12	6,14	52,88	,5377
87	,94821	—	96,36	190,18	6,18	52,58	,5347
86	,94870	—	97,48	191,26	6,22	52,28	,5317
100 + 85	,94920	—	98,63	192,37	6,26	51,98	,5286
84	,94970	—	99,80	193,51	6,29	51,68	,5255
83	,95021	—	101,00	194,67	6,33	51,37	,5224
82	,95071	—	102,24	195,86	6,38	51,06	,5192
81	,95122	—	103,50	197,09	6,41	50,74	,5160
100 + 80	,95173	—	104,79	198,34	6,45	50,42	,5127
79	,95224	—	106,12	199,62	6,50	50,09	,5094
78	,95275	—	107,48	200,95	6,53	49,76	,5060
77	,95327	—	108,88	202,31	6,57	49,43	,5026
76	,95378	—	110,31	203,70	6,61	49,09	,4992
100 + 75	,95429	—	111,78	205,13	6,65	48,75	,4957
74	,95479	—	113,29	206,61	6,68	48,40	,4922
73	,95529	—	114,84	208,13	6,71	48,05	,4886
72	,95580	—	116,44	209,69	6,75	47,69	,4850
71	,95630	—	118,08	211,29	6,79	47,33	,4813
100 + 70	,95681	—	119,76	212,94	6,82	46,96	,4775
69	,95733	—	121,49	214,64	6,85	46,59	,4738
68	,95786	—	123,28	216,39	6,89	46,21	,4700
67	,95838	—	126,12	218,19	6,93	45,83	,4661
66	,95891	—	127,02	220,05	6,97	45,44	,4621
100 + 65	,95944	—	128,98	221,97	7,01	45,05	,4581
64	,95997	—	130,99	223,95	7,04	44,65	,4541
63	,96050	—	133,06	225,99	7,07	44,25	,4500
62	,96103	—	135,21	228,10	7,11	43,84	,4458
61	,96156	—	137,43	230,28	7,15	43,43	,4416
100 + 60	,96209	—	139,72	232,54	7,18	43,00	,4373
59	,96262	—	142,08	234,87	7,21	42,58	,4330
58	,96314	—	144,53	237,29	7,24	42,14	,4286
57	,96367	—	147,07	239,80	7,27	41,70	,4241
56	,96418	—	149,70	242,40	7,30	41,25	,4195
100 + 55	,96470	—	152,42	245,09	7,33	40,80	,4149
54	,96520	—	155,22	247,87	7,35	40,34	,4102
53	,96570	—	158,14	250,77	7,37	39,87	,4054
52	,96620	—	161,19	253,79	7,40	39,40	,4006
51	,96670	—	164,36	256,92	7,44	38,92	,3957

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96719	100	167,67	260,19	7,48	38,43	,3908
49	,96769	—	171,09	263,63	7,46	37,93	,3858
48	,96819	—	174,65	267,18	7,47	37,43	,3806
47	,96869	—	178,37	270,89	7,48	36,92	,3754
46	,96919	—	182,25	274,75	7,50	36,40	,3701
100 + 45	,96967	—	186,30	278,79	7,51	35,87	,3648
44	,97015	—	190,53	283,02	7,51	35,33	,3593
43	,97062	—	194,96	287,46	7,50	34,79	,3538
42	,97109	—	199,60	292,11	7,49	34,23	,3482
41	,97155	—	204,47	296,98	7,49	33,67	,3424
100 + 40	,97200	—	209,58	302,12	7,46	33,10	,3366
39	,97244	—	214,96	307,49	7,47	32,52	,3307
38	,97288	—	220,62	313,17	7,45	31,94	,3247
37	,97332	—	226,58	319,17	7,41	31,34	,3186
36	,97375	—	232,87	325,51	7,36	30,73	,3124
100 + 35	,97418	—	239,53	332,18	7,35	30,11	,3061
34	,97461	—	246,57	339,26	7,31	29,48	,2997
33	,97504	—	254,04	346,79	7,25	28,84	,2932
32	,97548	—	261,98	354,79	7,19	28,19	,2866
31	,97591	—	270,43	363,29	7,14	27,53	,2799
100 + 30	,97635	—	279,44	372,36	7,08	26,86	,2731
29	,97679	—	289,08	382,04	7,04	26,17	,2662
28	,97723	—	299,41	392,43	6,98	25,48	,2591
27	,97768	—	310,50	403,60	6,90	24,78	,2519
26	,97814	—	322,44	415,63	6,81	24,06	,2446
100 + 25	,97860	—	335,34	428,65	6,69	23,33	,2372
24	,97906	—	349,31	442,73	6,58	22,59	,2297
23	,97954	—	364,49	458,03	6,46	21,83	,2220
22	,98004	—	381,06	474,72	6,34	21,06	,2142
21	,98055	—	399,21	492,99	6,22	20,28	,2063
100 + 20	,98108	—	419,17	513,08	6,09	19,49	,1982
19	,98163	—	441,23	535,29	5,94	18,68	,1900
18	,98221	—	465,74	559,95	5,79	17,86	,1816
17	,98282	—	493,14	587,50	5,64	17,02	,1731
16	,98345	—	523,96	618,48	5,48	16,17	,1644
100 + 15	,98412	—	558,89	653,58	5,31	15,30	,1556
14	,98481	—	598,81	693,69	5,12	14,41	,1466
13	,98555	—	644,88	739,94	4,94	13,51	,1375
12	,98633	—	698,62	793,88	4,74	12,59	,1281
11	,98716	—	762,13	857,59	4,54	11,66	,1186
100 + 10	,98804	—	838,34	934,04	4,30	10,71	,1089
9	,98896	—	931,49	1027,42	4,07	9,73	,0990
8	,98995	—	1047,92	1144,10	3,82	8,74	,0889
7	,99101	—	1197,63	1294,05	3,58	7,73	,0786
6	,99214	—	1397,23	1493,91	3,32	6,69	,0681
100 + 5	,99334	—	1676,68	1773,63	3,05	5,64	,0573
4	,99463	—	2095,85	2193,08	2,77	4,56	,0464
3	,99602	—	2794,46	2891,94	2,52	3,46	,0352
2	,99751	—	4191,71	4289,38	2,33	2,33	,0237
1	,99910	—	8383,40	8481,13	2,27	1,18	,0120

TABLE I. HEAT 31°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83852	100	—	100,00	—	100,00	1,0164
1	,84084	—	0,84	100,72	0,12	99,28	1,0091
2	,84310	—	1,68	101,45	0,23	98,57	1,0019
3	,84530	—	2,51	102,18	0,33	97,87	,9948
4	,84743	—	3,35	102,91	0,44	97,18	,9877
100 + 5	,84950	—	4,19	103,64	0,55	96,49	,9807
6	,85152	—	5,03	104,38	0,65	95,80	,9738
7	,85349	—	5,87	105,12	0,75	95,13	,9669
8	,85541	—	6,71	105,87	0,84	94,46	,9601
9	,85728	—	7,54	106,61	0,93	93,80	,9534
100 + 10	,85911	—	8,38	107,36	1,02	93,14	,9467
11	,86092	—	9,22	108,11	1,11	92,50	,9401
12	,86270	—	10,05	108,86	1,19	91,86	,9336
13	,86443	—	10,89	109,61	1,28	91,23	,9272
14	,86613	—	11,72	110,37	1,35	90,61	,9209
100 + 15	,86778	—	12,56	111,12	1,44	89,99	,9146
16	,86937	—	13,41	111,88	1,53	89,38	,9084
17	,87092	—	14,24	112,63	1,61	88,77	,9023
18	,87244	—	15,08	113,39	1,69	88,17	,8963
19	,87394	—	15,92	114,15	1,77	87,58	,8903
100 + 20	,87539	—	16,76	114,91	1,85	87,00	,8842
21	,87683	—	17,59	115,68	1,91	86,42	,8784
22	,87826	—	18,43	116,45	1,98	85,85	,8726
23	,87966	—	19,27	117,21	2,06	85,29	,8669
24	,88103	—	20,11	117,98	2,13	84,73	,8612
100 + 25	,88238	—	20,95	118,75	2,20	84,18	,8556
26	,88370	—	21,79	119,53	2,26	83,64	,8501
27	,88500	—	22,62	120,31	2,31	83,10	,8447
28	,88628	—	23,46	121,09	2,37	82,57	,8393
29	,88753	—	24,30	121,87	2,43	82,05	,8340
100 + 30	,88877	—	25,14	122,65	2,49	81,53	,8287
31	,88999	—	25,97	123,42	2,55	81,02	,8235
32	,89120	—	26,81	124,20	2,61	80,51	,8184
33	,89238	—	27,65	124,97	2,68	80,01	,8133
34	,89354	—	28,48	125,75	2,73	79,52	,8083
100 + 35	,89468	—	29,32	126,52	2,80	79,03	,8033
36	,89580	—	30,16	127,30	2,86	78,55	,7984
37	,89690	—	31,00	128,08	2,92	78,07	,7936
38	,89799	—	31,84	128,86	2,98	77,60	,7887
39	,89906	—	32,67	129,64	3,03	77,13	,7841
100 + 40	,90011	—	33,52	130,42	3,10	76,67	,7793
41	,90115	—	34,36	131,20	3,16	76,21	,7748
42	,90218	—	35,19	131,98	3,21	75,76	,7702
43	,90319	—	36,03	132,76	3,27	75,32	,7657
44	,90418	—	36,86	133,54	3,32	74,88	,7612
100 + 45	,90516	—	37,70	134,32	3,38	74,45	,7567
46	,90612	—	38,53	135,11	3,42	74,01	,7523
47	,90707	—	39,37	135,89	3,48	73,59	,7480
48	,90800	—	40,21	136,68	3,53	73,17	,7437
49	,90891	—	41,06	137,46	3,60	72,74	,7394

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90980	100	41,90	138,25	3,65	72,33	,7352
51	,91069	—	42,72	139,03	3,69	71,92	,7311
52	,91155	—	43,57	139,82	3,75	71,51	,7270
53	,91241	—	44,40	140,61	3,79	71,12	,7229
54	,91325	—	45,24	141,40	3,84	70,72	,7188
100 + 55	,91408	—	46,08	142,18	3,90	70,33	,7148
56	,91490	—	46,92	142,97	3,95	69,94	,7109
57	,91571	—	47,75	143,76	3,99	69,56	,7070
58	,91650	—	48,59	144,55	4,04	69,18	,7031
59	,91729	—	49,43	145,34	4,09	68,80	,6993
100 + 60	,91806	—	50,27	146,13	4,14	68,43	,6955
61	,91882	—	51,11	146,92	4,19	68,06	,6917
62	,91957	—	51,95	147,71	4,24	67,69	,6880
63	,92031	—	52,78	148,50	4,28	67,34	,6843
64	,92104	—	53,62	149,30	4,32	66,98	,6807
100 + 65	,92176	—	54,46	150,09	4,37	66,63	,6771
66	,92247	—	55,29	150,88	4,41	66,28	,6736
67	,92317	—	56,14	151,68	4,46	65,92	,6701
68	,92386	—	56,97	152,47	4,50	65,58	,6666
69	,92455	—	57,80	153,27	4,53	65,24	,6631
100 + 70	,92522	—	58,64	154,06	4,58	64,91	,6597
71	,92588	—	59,48	154,86	4,62	64,57	,6563
72	,92653	—	60,32	155,66	4,66	64,24	,6530
73	,92717	—	61,16	156,46	4,70	63,91	,6497
74	,92780	—	62,00	157,25	4,75	63,59	,6464
100 + 75	,92848	—	62,83	158,04	4,79	63,27	,6431
76	,92910	—	63,67	158,83	4,84	62,96	,6399
77	,92971	—	64,51	159,64	4,87	62,63	,6367
78	,93036	—	65,35	160,43	4,92	62,33	,6335
79	,93091	—	66,19	161,23	4,96	62,02	,6303
100 + 80	,93150	—	67,03	162,03	5,00	61,72	,6273
81	,93209	—	67,86	162,82	5,04	61,41	,6242
82	,93266	—	68,70	163,62	5,08	61,12	,6212
83	,93323	—	69,54	164,42	5,12	60,81	,6182
84	,93379	—	70,38	165,22	5,16	60,52	,6151
100 + 85	,93434	—	71,22	166,03	5,19	60,23	,6122
86	,93489	—	72,05	166,83	5,22	59,95	,6093
87	,93543	—	72,89	167,63	5,26	59,66	,6064
88	,93596	—	73,72	168,43	5,29	59,37	,6035
89	,93649	—	74,56	169,23	5,33	59,09	,6006
100 + 90	,93701	—	75,40	170,03	5,37	58,82	,5978
91	,93752	—	76,24	170,83	5,41	58,53	,5950
92	,93802	—	77,08	171,63	5,45	58,27	,5922
93	,93852	—	77,91	172,43	5,48	58,00	,5895
94	,93901	—	78,75	173,24	5,51	57,73	,5868
100 + 95	,93950	—	79,59	174,03	5,56	57,46	,5841
96	,93998	—	80,42	174,84	5,58	57,20	,5814
97	,94045	—	81,25	175,64	5,61	56,93	,5788
98	,94092	—	82,09	176,44	5,65	56,67	,5761
99	,94138	—	82,93	177,25	5,68	56,42	,5734

TABLE II. HEAT 31°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,94183	100	83,78	178,06	5,72	56,15	,5708
99	,94228	—	84,64	178,88	5,76	55,90	,5682
98	,94273	—	85,51	179,72	5,79	55,64	,5656
97	,94318	—	86,38	180,57	5,81	55,37	,5629
96	,94363	—	87,29	181,43	5,86	55,12	,5602
100 + 95	,94408	—	88,20	182,31	5,89	54,84	,5575
94	,94453	—	89,13	183,22	5,91	54,57	,5548
93	,94498	—	90,09	184,15	5,94	54,30	,5520
92	,94544	—	91,07	185,09	5,98	54,02	,5492
91	,94591	—	92,08	186,07	6,01	53,75	,5463
100 + 90	,94636	—	93,10	187,06	6,04	53,46	,5434
89	,94685	—	94,14	188,06	6,08	53,17	,5405
88	,94734	—	95,21	189,10	6,11	52,89	,5375
87	,94784	—	96,31	190,16	6,15	52,59	,5345
86	,94833	—	97,42	191,24	6,18	52,29	,5315
100 + 85	,94883	—	98,58	192,35	6,23	51,99	,5284
84	,94933	—	99,75	193,49	6,26	51,69	,5253
83	,94984	—	100,94	194,65	6,29	51,37	,5222
82	,95034	—	102,18	195,83	6,35	51,06	,5190
81	,95085	—	103,44	197,06	6,38	50,75	,5158
100 + 80	,95136	—	104,73	198,32	6,41	50,43	,5125
79	,95188	—	106,06	199,60	6,46	50,10	,5092
78	,95239	—	107,42	200,92	6,50	49,76	,5058
77	,95291	—	108,82	202,28	6,54	49,44	,5024
76	,95342	—	110,25	203,67	6,58	49,09	,4990
100 + 75	,95392	—	111,72	205,10	6,62	48,75	,4955
74	,95443	—	113,22	206,58	6,64	48,41	,4921
73	,95493	—	114,77	208,10	6,67	48,05	,4885
72	,95544	—	116,38	209,66	6,72	47,69	,4849
71	,95594	—	118,01	211,25	6,76	47,34	,4812
100 + 70	,95646	—	119,69	212,90	6,79	46,97	,4774
69	,95698	—	121,42	214,60	6,82	46,59	,4736
68	,95751	—	123,21	216,35	6,86	46,21	,4699
67	,95803	—	126,05	218,16	6,89	45,83	,4660
66	,95857	—	126,94	220,01	6,93	45,45	,4620
100 + 65	,95910	—	128,91	221,93	6,98	45,06	,4580
64	,95963	—	130,92	223,91	7,01	44,66	,4540
63	,96017	—	132,98	225,95	7,03	44,26	,4499
62	,96070	—	135,13	228,06	7,07	43,85	,4457
61	,96124	—	137,35	230,23	7,12	43,44	,4415
100 + 60	,96177	—	139,64	232,50	7,14	43,01	,4372
59	,96230	—	142,00	234,83	7,17	42,59	,4329
58	,96283	—	144,45	237,24	7,21	42,15	,4285
57	,96336	—	146,99	239,75	7,24	41,71	,4240
56	,96387	—	149,62	242,34	7,28	41,26	,4194
100 + 55	,96439	—	152,33	245,03	7,30	40,81	,4148
54	,96490	—	155,13	247,81	7,32	40,35	,4101
53	,96541	—	158,05	250,71	7,34	39,88	,4053
52	,96591	—	161,10	253,73	7,37	39,41	,4005
51	,96642	—	164,26	256,87	7,39	38,93	,3956

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96691	100	167,57	260,13	7,44	38,44	,3907
49	,96742	—	170,99	263,56	7,43	37,94	,3857
48	,96792	—	174,55	267,11	7,44	37,44	,3805
47	,96843	—	178,26	270,81	7,45	36,93	,3754
46	,96893	—	182,14	274,67	7,47	36,41	,3701
100 + 45	,96941	—	186,19	278,72	7,47	35,88	,3647
44	,96990	—	190,42	282,94	7,48	35,34	,3592
43	,97038	—	194,85	287,37	7,48	34,79	,3537
42	,97085	—	199,48	292,02	7,46	34,24	,3481
41	,97132	—	204,35	296,89	7,46	33,68	,3424
100 + 40	,97178	—	209,46	302,02	7,44	33,11	,3365
39	,97222	—	214,83	307,39	7,44	32,53	,3307
38	,97267	—	220,49	313,07	7,42	31,94	,3247
37	,97311	—	226,45	319,07	7,38	31,34	,3186
36	,97355	—	232,73	325,40	7,33	30,73	,3124
100 + 35	,97399	—	239,39	332,07	7,32	30,12	,3061
54	,97442	—	246,43	339,15	7,28	29,49	,2997
33	,97486	—	253,89	346,67	7,22	28,85	,2932
32	,97531	—	261,83	354,66	7,17	28,20	,2866
31	,97575	—	270,27	363,16	7,11	27,54	,2799
100 + 30	,97620	—	279,28	372,22	7,06	26,87	,2731
29	,97664	—	288,91	381,90	7,01	26,18	,2662
28	,97709	—	299,24	392,29	6,95	25,49	,2591
27	,97755	—	310,32	403,44	6,88	24,78	,2519
26	,97802	—	322,25	415,47	6,78	24,07	,2446
100 + 25	,97849	—	335,15	428,47	6,68	23,34	,2372
24	,97896	—	349,11	442,54	6,57	22,59	,2297
23	,97945	—	364,28	457,83	6,45	21,84	,2220
22	,97996	—	381,84	474,50	6,34	21,07	,2142
21	,98048	—	398,98	492,76	6,22	20,29	,2063
100 + 20	,98102	—	418,93	512,84	6,09	19,50	,1982
19	,98158	—	440,98	535,03	5,95	18,69	,1900
18	,98216	—	465,47	559,68	5,79	17,87	,1816
17	,98278	—	492,86	587,21	5,65	17,03	,1731
16	,98342	—	523,66	618,17	5,49	16,17	,1644
100 + 15	,98409	—	558,57	653,25	5,32	15,31	,1556
14	,98479	—	598,47	693,33	5,14	14,42	,1466
13	,98554	—	644,51	739,55	4,96	13,52	,1375
12	,98632	—	698,22	793,46	4,76	12,60	,1281
11	,98716	—	761,69	857,13	4,56	11,67	,1186
100 + 10	,98804	—	837,86	933,54	4,32	10,71	,1089
9	,98896	—	930,96	1026,86	4,10	9,74	,0990
8	,98997	—	1047,32	1143,47	3,85	8,74	,0889
7	,99103	—	1196,95	1293,34	3,61	7,73	,0786
6	,99216	—	1396,44	1493,08	3,36	6,70	,0681
100 + 5	,99336	—	1675,73	1772,64	3,09	5,64	,0573
4	,99466	—	2094,65	2191,85	2,80	4,56	,0464
3	,99605	—	2792,86	2890,32	2,54	3,46	,0352
2	,99754	—	4189,30	4886,96	2,34	2,33	,0237
1	,99913	—	8378,58	8476,39	2,19	1,18	,0120

TABLE I. HEAT 32°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83807	100	—	100,00	—	100,00	1,0158
1	,84039	—	0,84	100,72	0,12	99,28	1,0086
2	,84265	—	1,68	101,45	0,23	98,57	1,0014
3	,84485	—	2,51	102,18	0,33	97,87	,9943
4	,84698	—	3,35	102,91	0,44	97,18	,9872
100 + 5	,84905	—	4,19	103,64	0,55	96,49	,9801
6	,85107	—	5,03	104,38	0,65	95,80	,9733
7	,85304	—	5,87	105,12	0,75	95,13	,9664
8	,85496	—	6,70	105,87	0,83	94,46	,9596
9	,85683	—	7,54	106,61	0,93	93,80	,9529
100 + 10	,85866	—	8,37	107,36	1,01	93,14	,9462
11	,86046	—	9,21	108,11	1,10	92,50	,9396
12	,86224	—	10,05	108,86	1,19	91,86	,9331
13	,86396	—	10,88	109,61	1,27	91,23	,9267
14	,86565	—	11,72	110,37	1,35	90,61	,9204
100 + 15	,86730	—	12,56	111,12	1,44	89,99	,9141
16	,86890	—	13,40	111,88	1,52	89,38	,9079
17	,87045	—	14,23	112,64	1,59	88,77	,9018
18	,87198	—	15,07	113,40	1,67	88,17	,8958
19	,87348	—	15,91	114,16	1,75	87,58	,8898
100 + 20	,87494	—	16,75	114,92	1,83	87,00	,8838
21	,87638	—	17,58	115,68	1,90	86,42	,8779
22	,87780	—	18,42	116,45	1,97	85,85	,8721
23	,87921	—	19,26	117,22	2,04	85,29	,8664
24	,88059	—	20,10	117,99	2,11	84,73	,8607
100 + 25	,88193	—	20,94	118,76	2,18	84,18	,8552
26	,88326	—	21,77	119,53	2,24	83,64	,8497
27	,88456	—	22,61	120,31	2,30	83,11	,8443
28	,88584	—	23,45	121,09	2,36	82,58	,8389
29	,88709	—	24,28	121,86	2,42	82,05	,8336
100 + 30	,88833	—	25,12	122,64	2,48	81,53	,8283
31	,88955	—	25,96	123,42	2,54	81,02	,8231
32	,89076	—	26,80	124,19	2,61	80,52	,8180
33	,89195	—	27,64	124,97	2,67	80,02	,8129
34	,89311	—	28,47	125,75	2,72	79,53	,8079
100 + 35	,89424	—	29,31	126,52	2,79	79,03	,8029
36	,89537	—	30,15	127,30	2,85	78,56	,7980
37	,89647	—	30,99	128,07	2,92	78,08	,7932
38	,89756	—	31,83	128,85	2,98	77,61	,7884
39	,88863	—	32,65	129,63	3,02	77,14	,7837
100 + 40	,89968	—	33,50	130,41	3,09	76,67	,7789
41	,90072	—	34,34	131,19	3,15	76,22	,7744
42	,90175	—	35,17	131,97	3,20	75,77	,7698
43	,90276	—	36,01	132,75	3,26	75,33	,7653
44	,90376	—	36,84	133,53	3,31	74,89	,7608
100 + 45	,90474	—	37,68	134,31	3,37	74,45	,7563
46	,90570	—	38,51	135,10	3,41	74,02	,7520
47	,90665	—	39,35	135,88	3,47	73,59	,7477
48	,90758	—	40,19	136,67	3,52	73,17	,7434
49	,90849	—	41,03	137,45	3,58	72,75	,7391

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90937	100	41,87	138,24	3,63	72,34	,7348
51	,91027	—	42,70	139,02	3,68	71,93	,7308
52	,91113	—	43,54	139,81	3,73	71,52	,7266
53	,91199	—	44,38	140,60	3,78	71,12	,7226
54	,91284	—	45,22	141,39	3,83	70,73	,7185
100 + 55	,91367	—	46,06	142,17	3,89	70,34	,7145
56	,91448	—	46,90	142,96	3,94	69,95	,7106
57	,91530	—	47,73	143,75	3,98	69,56	,7067
58	,91609	—	48,56	144,54	4,02	69,18	,7028
59	,91687	—	49,40	145,33	4,07	68,81	,6990
100 + 60	,91764	—	50,24	146,12	4,12	68,43	,6952
61	,91840	—	51,08	146,91	4,17	68,06	,6914
62	,91916	—	51,92	147,70	4,22	67,70	,6877
63	,91990	—	52,75	148,49	4,26	67,34	,6840
64	,92063	—	53,59	149,29	4,30	66,98	,6804
100 + 65	,92135	—	54,43	150,08	4,35	66,63	,6769
66	,92206	—	55,26	150,87	4,39	66,28	,6733
67	,92276	—	56,11	151,67	4,44	65,93	,6698
68	,92345	—	56,94	152,46	4,48	65,59	,6663
69	,92413	—	57,77	153,26	4,51	65,25	,6628
100 + 70	,92481	—	58,61	154,05	4,56	64,91	,6594
71	,92547	—	59,45	154,85	4,60	64,58	,6560
72	,92612	—	60,28	155,64	4,64	64,25	,6527
73	,92676	—	61,12	156,44	4,68	63,92	,6494
74	,92739	—	61,97	157,24	4,73	63,60	,6461
100 + 75	,92806	—	62,80	158,03	4,77	63,28	,6428
76	,92869	—	63,64	158,82	4,82	62,96	,6396
77	,92930	—	64,48	159,63	4,85	62,64	,6364
78	,92994	—	65,31	160,42	4,89	62,33	,6333
79	,93050	—	66,15	161,22	4,93	62,03	,6300
100 + 80	,93109	—	67,00	162,02	4,98	61,72	,6270
81	,93168	—	67,82	162,81	5,01	61,42	,6240
82	,93226	—	68,66	163,61	5,05	61,12	,6210
83	,93283	—	69,50	164,41	5,09	60,82	,6179
84	,93339	—	70,34	165,21	5,13	60,53	,6149
100 + 85	,93394	—	71,18	166,01	5,17	60,23	,6119
86	,93449	—	72,01	166,81	5,20	59,95	,6091
87	,93503	—	72,85	167,61	5,24	59,66	,6062
88	,93556	—	73,68	168,41	5,27	59,38	,6032
89	,93609	—	74,52	169,21	5,31	59,10	,6004
100 + 90	,93661	—	75,36	170,01	5,35	58,82	,5975
91	,93712	—	76,20	170,82	5,38	58,54	,5948
92	,93762	—	77,04	171,62	5,42	58,27	,5920
93	,93812	—	77,87	172,42	5,45	58,00	,5892
94	,93861	—	78,71	173,22	5,49	57,73	,5866
100 + 95	93910	—	79,55	174,02	5,53	57,46	,5838
96	,93958	—	80,38	174,82	5,56	57,21	,5812
97	,94005	—	81,21	175,62	5,59	56,94	,5785
98	,94052	—	82,04	176,42	5,62	56,68	,5758
99	,94099	—	82,88	177,23	5,65	56,42	,5732

TABLE II. HEAT 32°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,94144	100	83,74	178,04	5,70	56,16	,5706	100 + 50	,96663	100	167,48	260,08	7,40	38,44	,3905
99	,94189	—	84,59	178,86	5,73	55,91	,5679	49	,96714	—	170,89	263,50	7,39	37,95	,3856
98	,94233	—	85,46	179,70	5,76	55,65	,5653	48	,96765	—	174,45	267,04	7,41	37,45	,3804
97	,94278	—	86,33	180,55	5,78	55,38	,5626	47	,96816	—	178,16	270,73	7,43	36,94	,3752
96	,94323	—	87,24	181,41	5,83	55,12	,5600	46	,96867	—	182,03	274,59	7,44	36,42	,3700
100 + 95	,94369	—	88,15	182,29	5,86	54,85	,5573	100 + 45	,96915	—	186,08	278,64	7,44	35,89	,3646
94	,94413	—	89,08	183,20	5,88	54,58	,5545	44	,96965	—	190,31	282,86	7,45	35,35	,3591
93	,94459	—	90,04	184,12	5,92	54,31	,5517	43	,97013	—	194,74	287,29	7,45	34,80	,3536
92	,94505	—	91,02	185,07	5,95	54,03	,5489	42	,97061	—	199,37	291,94	7,43	34,25	,3480
91	,94552	—	92,02	186,04	5,98	53,75	,5461	41	,97108	—	204,23	296,80	7,43	33,69	,3423
100 + 90	,94598	—	93,04	187,03	6,01	53,47	,5431	100 + 40	,97155	—	209,34	301,92	7,42	33,12	,3365
89	,94647	—	94,08	188,04	6,04	53,18	,5403	39	,97200	—	214,71	307,29	7,42	32,54	,3306
88	,94696	—	95,15	189,07	6,08	52,89	,5373	38	,97245	—	220,36	312,97	7,39	31,95	,3246
87	,94746	—	96,25	190,13	6,12	52,59	,5343	37	,97290	—	226,32	318,97	7,35	31,35	,3185
86	,94795	—	97,37	191,21	6,16	52,30	,5313	36	,97335	—	232,60	325,30	7,30	30,74	,3123
100 + 85	,94845	—	98,52	192,32	6,20	51,99	,5282	100 + 35	,97379	—	239,25	331,96	7,29	30,12	,3060
84	,94896	—	99,69	193,46	6,23	51,69	,5251	34	,97423	—	246,29	339,03	7,26	29,50	,2996
83	,94947	—	100,89	194,62	6,27	51,38	,5220	33	,97468	—	253,74	346,55	7,19	28,86	,2931
82	,94997	—	102,12	195,81	6,31	51,07	,5188	32	,97513	—	261,68	354,54	7,14	28,21	,2865
81	,95048	—	103,38	197,03	6,35	50,76	,5156	31	,97558	—	270,12	363,03	7,09	27,55	,2798
100 + 80	,95099	—	104,67	198,29	6,38	50,44	,5123	100 + 30	,97604	—	279,12	372,08	7,04	26,88	,2730
79	,95151	—	106,00	199,57	6,43	50,11	,5090	29	,97649	—	288,74	381,76	6,98	26,19	,2661
78	,95202	—	107,36	200,89	6,47	49,77	,5046	28	,97695	—	299,07	392,15	6,92	25,50	,2591
77	,95254	—	108,76	202,25	6,51	49,45	,5022	27	,97741	—	310,14	403,29	6,85	24,79	,2519
76	,95305	—	110,19	203,64	6,55	49,10	,4988	26	,97789	—	322,06	415,31	6,73	24,08	,2446
100 + 75	,95355	—	111,66	205,07	6,59	48,76	,4953	100 + 25	,97837	—	334,96	428,30	6,66	23,35	,2372
74	,95406	—	113,15	206,55	6,60	48,42	,4919	24	,97885	—	348,91	442,35	6,56	22,60	,2297
73	,95457	—	114,70	208,06	6,64	48,06	,4883	23	,97935	—	364,07	457,63	6,44	21,85	,2220
72	,95508	—	116,31	209,63	6,68	47,70	,4847	22	,97987	—	381,62	474,29	6,33	21,08	,2142
71	,95558	—	117,94	211,22	6,72	47,34	,4810	21	,98040	—	398,75	492,53	6,22	20,30	,2063
100 + 70	,95610	—	119,62	212,87	6,75	46,98	,4772	100 + 20	,98096	—	418,69	512,60	6,09	19,51	,1981
69	,95662	—	121,35	214,57	6,78	46,60	,4734	19	,98152	—	440,73	534,77	5,96	18,70	,1900
68	,95715	—	123,14	216,31	6,83	46,22	,4697	18	,98211	—	465,20	559,41	5,79	17,87	,1816
67	,95768	—	124,98	218,12	6,86	45,84	,4658	17	,98273	—	492,58	586,92	5,66	17,04	,1731
66	,95822	—	126,87	219,98	6,89	45,46	,4618	16	,98338	—	523,36	617,86	5,50	16,18	,1644
100 + 65	,95875	—	128,83	221,89	6,94	45,07	,4578	100 + 15	,98406	—	558,25	652,92	5,33	15,32	,1556
64	,95929	—	130,84	223,87	6,97	44,67	,4538	14	,98477	—	598,13	692,97	5,16	14,42	,1466
63	,95983	—	132,90	225,91	6,99	44,26	,4497	13	,98552	—	644,14	739,17	4,97	13,53	,1375
62	,96037	—	135,05	228,01	7,04	43,85	,4455	12	,98631	—	697,82	793,04	4,78	12,61	,1281
61	,96091	—	137,27	230,19	7,08	43,44	,4413	11	,98715	—	761,26	856,68	4,58	11,67	,1186
100 + 60	,96145	—	139,56	232,45	7,11	43,02	,4370	100 + 10	,98804	—	837,38	933,04	4,34	10,72	,1089
59	,96198	—	141,92	234,78	7,14	42,60	,4327	9	,98897	—	930,43	1026,30	4,13	9,74	,0990
58	,96251	—	144,36	237,19	7,17	42,16	,4283	8	,98998	—	1046,72	1142,85	3,87	8,75	,0889
57	,96304	—	146,90	239,70	7,20	41,72	,4238	7	,99105	—	1196,27	1292,63	3,64	7,73	,0786
56	,96356	—	149,53	242,29	7,24	41,27	,4193	6	,99218	—	1395,65	1492,25	3,40	6,70	,0681
100 + 55	,96408	—	152,24	244,97	7,27	40,82	,4146	100 + 5	,99338	—	1674,78	1771,65	3,13	5,64	,0573
54	,96459	—	155,04	247,75	7,29	40,36	,4100	4	,99469	—	2093,45	2190,63	2,82	4,56	,0464
53	,96511	—	157,96	250,66	7,30	39,89	,4052	3	,99608	—	2791,27	2888,71	2,56	3,46	,0352
52	,96562	—	161,01	253,68	7,33	39,42	,4004	2	,99757	—	4186,91	4284,58	2,33	2,33	,0237
51	,96613	—	164,17	256,81	7,36	38,93	,3955	1	,99916	—	8373,79	8471,67	2,12	1,18	,0120

TABLE I. HEAT 33°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83762	100	—	100,00	—	100,00	1,0153
1	,83994	—	0,84	100,72	0,12	99,28	1,0081
2	,84220	—	1,68	101,45	0,23	98,57	1,0009
3	,84440	—	2,51	102,18	0,33	97,87	,9938
4	,84653	—	3,35	102,91	0,44	97,18	,9867
100 + 5	,84860	—	4,19	103,64	0,55	96,49	,9796
6	,85062	—	5,03	104,38	0,65	95,80	,9728
7	,85259	—	5,86	105,12	0,74	95,13	,9659
8	,85451	—	6,70	105,87	0,83	94,46	,9591
9	,85638	—	7,53	106,61	0,92	93,80	,9524
100 + 10	,85820	—	8,37	107,36	1,01	93,14	,9457
11	,86000	—	9,21	108,11	1,10	92,50	,9391
12	,86178	—	10,04	108,86	1,18	91,86	,9326
13	,86349	—	10,88	109,61	1,27	91,23	,9262
14	,86518	—	11,71	110,37	1,34	90,61	,9199
100 + 15	,86683	—	12,55	111,12	1,43	89,99	,9136
16	,86842	—	13,39	111,88	1,51	89,38	,9074
17	,86998	—	14,23	112,64	1,59	88,77	,9013
18	,87151	—	15,07	113,40	1,67	88,17	,8953
19	,87302	—	15,90	114,16	1,74	87,58	,8893
100 + 20	,87448	—	16,74	114,92	1,82	87,00	,8833
21	,87592	—	17,57	115,69	1,88	86,42	,8774
22	,87735	—	18,41	116,46	1,95	85,85	,8717
23	,87876	—	19,25	117,22	2,03	85,29	,8660
24	,88014	—	20,09	117,99	2,10	84,73	,8603
100 + 25	,88149	—	20,93	118,76	2,17	84,18	,8548
26	,88281	—	21,76	119,53	2,23	83,64	,8493
27	,88412	—	22,59	120,31	2,28	83,11	,8439
28	,88540	—	23,44	121,08	2,36	82,58	,8385
29	,88665	—	24,27	121,86	2,41	82,05	,8332
100 + 30	,88789	—	25,11	122,64	2,47	81,53	,8279
31	,88911	—	25,94	123,41	2,53	81,03	,8227
32	,89032	—	26,78	124,19	2,59	80,52	,8176
33	,89151	—	27,62	124,96	2,66	80,02	,8125
34	,89267	—	28,45	125,74	2,71	79,53	,8075
100 + 35	,89380	—	29,29	126,51	2,78	79,04	,8025
36	,89494	—	30,13	127,29	2,84	78,56	,7976
37	,89604	—	30,97	128,06	2,91	78,08	,7928
38	,89713	—	31,81	128,84	2,97	77,61	,7880
39	,88820	—	32,63	129,63	3,00	77,14	,7833
100 + 40	,89925	—	33,48	130,41	3,07	76,68	,7785
41	,90029	—	34,32	131,19	3,13	76,22	,7740
42	,90132	—	35,15	131,97	3,18	75,77	,7694
43	,90233	—	35,99	132,75	3,24	75,33	,7649
44	,90333	—	36,82	133,53	3,29	74,89	,7604
100 + 45	,90431	—	37,66	134,31	3,35	74,46	,7559
46	,90527	—	38,49	135,09	3,40	74,02	,7517
47	,90622	—	39,33	135,87	3,46	73,60	,7473
48	,90715	—	40,17	136,66	3,51	73,18	,7431
49	,90807	—	41,01	137,44	3,57	72,75	,7388

I. Spirit and Water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90895	100	41,85	138,23	3,62	72,34	,7345
51	,90985	—	42,67	139,01	3,66	71,93	,7304
52	,91071	—	43,52	139,80	3,72	71,53	,7263
53	,91157	—	44,35	140,59	3,76	71,13	,7223
54	,91242	—	45,19	141,38	3,81	70,73	,7182
100 + 55	,91325	—	46,03	142,16	3,87	70,34	,7142
56	,91406	—	46,87	142,95	3,92	69,95	,7103
57	,91488	—	47,70	143,74	3,96	69,57	,7064
58	,91567	—	48,53	144,53	4,00	69,19	,7025
59	,91645	—	49,37	145,32	4,05	68,81	,6986
100 + 60	,91722	—	50,21	146,11	4,10	68,44	,6949
61	,91799	—	51,05	146,90	4,15	68,07	,6911
62	,91875	—	51,89	147,69	4,20	67,71	,6874
63	,91949	—	52,72	148,48	4,24	67,35	,6837
64	,92021	—	53,56	149,28	4,28	66,99	,6801
100 + 65	,92093	—	54,40	150,07	4,33	66,64	,6766
66	,92164	—	55,23	150,86	4,37	66,29	,6730
67	,92234	—	56,07	151,66	4,41	65,94	,6695
68	,92303	—	56,91	152,45	4,46	65,59	,6660
69	,92371	—	57,74	153,24	4,50	65,25	,6625
100 + 70	,92439	—	58,58	154,04	4,54	64,92	,6591
71	,92505	—	59,41	154,83	4,58	64,59	,6557
72	,92571	—	60,25	155,63	4,62	64,26	,6524
73	,92634	—	61,09	156,43	4,66	63,93	,6491
74	,92698	—	61,93	157,22	4,71	63,61	,6458
100 + 75	,92764	—	62,76	158,02	4,74	63,29	,6425
76	,92827	—	63,60	158,81	4,79	62,97	,6393
77	,92888	—	64,44	159,61	4,83	62,65	,6361
78	,92951	—	65,27	160,40	4,87	62,34	,6330
79	,93009	—	66,11	161,20	4,91	62,04	,6298
100 + 80	,93068	—	66,96	162,00	4,96	61,73	,6267
81	,93127	—	67,78	162,79	4,99	61,43	,6237
82	,93185	—	68,62	163,59	5,03	61,13	,6207
83	,93243	—	69,46	164,39	5,07	60,83	,6176
84	,93299	—	70,30	165,19	5,11	60,54	,6146
100 + 85	,93354	—	71,14	165,99	5,15	60,24	,6116
86	,93409	—	71,97	166,79	5,18	59,96	,6088
87	,93463	—	72,81	167,59	5,22	59,67	,6059
88	,93516	—	73,64	168,39	5,25	59,39	,6030
89	,93569	—	74,48	169,19	5,29	59,11	,6001
100 + 90	,93621	—	75,32	169,99	5,33	58,83	,5972
91	,93672	—	76,15	170,80	5,35	58,55	,5945
92	93722	—	77,99	171,60	5,39	58,28	,5917
93	,93772	—	77,82	172,40	5,42	58,01	,5890
94	,93821	—	78,66	173,20	5,46	57,74	,5863
100 + 95	,93870	—	79,50	174,00	5,50	57,47	,5835
96	,93918	—	80,33	174,80	5,53	57,21	,5809
97	,93965	—	81,16	175,60	5,56	56,95	,5783
98	,94012	—	82,00	176,40	5,60	56,69	,5756
99	,94059	—	82,84	177,21	5,63	56,43	,5730

TABLE II. HEAT 33°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,94105	100	83,69	178,02	5,67	56,16	,5703
99	,94149	—	84,54	178,84	5,70	55,91	,5677
98	,94194	—	85,41	179,68	5,73	55,65	,5651
97	,94239	—	86,28	180,53	5,75	55,39	,5624
96	,94284	—	87,19	181,39	5,80	55,13	,5598
100 + 95	,94329	—	88,10	182,27	5,83	54,85	,5570
94	,94374	—	89,03	183,18	5,85	54,59	,5543
93	,94420	—	89,99	184,10	5,89	54,32	,5515
92	,94466	—	90,97	185,04	5,93	54,04	,5487
91	,94513	—	91,97	186,02	5,95	53,76	,5459
100 + 90	,94560	—	92,99	187,00	5,99	53,48	,5429
89	,94609	—	94,03	188,01	6,02	53,19	,5401
88	,94658	—	95,10	189,05	6,05	52,90	,5371
87	,94708	—	96,20	190,10	6,10	52,60	,5341
86	,94758	—	97,31	191,19	6,12	52,31	,5311
100 + 85	,94808	—	98,47	192,29	6,18	52,00	,5280
84	,94859	—	99,64	193,43	6,21	51,70	,5249
83	,94910	—	100,83	194,59	6,24	51,39	,5218
82	,94960	—	102,06	195,78	6,28	51,08	,5186
81	,95011	—	103,32	197,00	6,32	50,77	,5154
100 + 80	,95062	—	104,61	198,26	6,35	50,45	,5121
79	,95114	—	105,94	199,54	6,40	50,11	,5088
78	,95165	—	107,30	200,86	6,44	49,78	,5044
77	,95217	—	108,69	202,22	6,47	49,46	,5020
76	,95268	—	110,13	203,61	6,52	49,11	,4986
100 + 75	,95319	—	111,59	205,04	6,55	48,77	,4952
74	,95370	—	113,09	206,52	6,57	48,42	,4917
73	,95421	—	114,64	208,03	6,61	48,07	,4881
72	,95472	—	116,24	209,59	6,65	47,71	,4845
71	,95522	—	117,87	211,19	6,68	47,35	,4808
100 + 70	,95574	—	119,55	212,83	6,72	46,99	,4770
69	,95626	—	121,28	214,53	6,75	46,61	,4732
68	,95680	—	123,07	216,28	6,79	46,23	,4695
67	,95733	—	124,91	218,09	6,82	45,85	,4656
66	,95787	—	126,80	219,94	6,86	45,47	,4616
100 + 65	,95840	—	128,75	221,85	6,90	45,08	,4576
64	,95895	—	130,77	223,83	6,94	44,68	,4536
63	,95949	—	132,83	225,86	6,97	44,27	,4495
62	,96004	—	134,97	227,97	7,00	43,86	,4453
61	,96058	—	137,19	230,14	7,05	43,45	,4411
100 + 60	,96112	—	139,48	232,41	7,07	43,03	,4369
59	,96166	—	141,84	234,73	7,11	42,60	,4325
58	,96219	—	144,28	237,14	7,14	42,17	,4281
57	,96272	—	146,82	239,65	7,17	41,73	,4236
56	,96325	—	149,45	242,24	7,21	41,28	,4192
100 + 55	,96377	—	152,16	244,92	7,24	40,83	,4145
54	,96429	—	154,95	247,70	7,25	40,37	,4099
53	,96481	—	157,87	250,60	7,27	39,90	,4051
52	,96533	—	160,92	253,62	7,30	39,43	,4003
51	,96584	—	164,08	256,76	7,32	38,94	,3954

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96635	100	167,38	260,02	7,36	38,45	,3904
49	,96687	—	170,79	263,43	7,36	37,96	,3855
48	,96738	—	174,35	266,97	7,38	37,46	,3803
47	,96790	—	178,06	270,66	7,40	36,95	,3752
46	,96841	—	181,93	274,51	7,42	36,43	,3699
100 + 45	,96890	—	185,97	278,56	7,41	35,90	,3645
44	,96940	—	190,20	282,78	7,42	35,36	,3590
43	,96989	—	194,63	287,20	7,43	34,81	,3535
42	,97037	—	199,26	291,85	7,41	34,26	,3479
41	,97085	—	204,11	296,71	7,40	33,70	,3422
100 + 40	,97132	—	209,22	301,82	7,40	33,13	,3364
39	,97178	—	214,59	307,20	7,39	32,55	,3305
38	,97223	—	220,23	312,87	7,36	31,96	,3245
37	,97269	—	226,19	318,87	7,32	31,36	,3184
36	,97315	—	232,47	325,19	7,28	30,75	,3122
100 + 35	,97359	—	239,11	331,85	7,26	30,13	,3059
34	,97404	—	246,15	338,92	7,23	29,51	,2996
33	97450	—	253,60	346,43	7,17	28,87	,2931
32	,97495	—	261,53	354,41	7,12	28,22	,2865
31	,97541	—	269,97	362,90	7,07	27,56	,2798
100 + 30	,97588	—	278,96	371,94	7,02	26,89	,2730
29	,97634	—	288,58	381,61	6,97	26,20	,2661
28	,97681	—	298,90	392,00	6,90	25,51	,2590
27	,97728	—	309,96	403,14	6,82	24,80	,2519
26	,97776	—	321,88	415,15	6,73	24,09	,2446
100 + 25	,97825	—	334,77	428,12	6,65	23,36	,2371
24	,97874	—	348,71	442,16	6,55	22,61	,2296
23	,97925	—	363,86	457,43	6,43	21,86	,2220
22	,97978	—	381,40	474,08	6,32	21,09	,2142
21	,98033	—	398,52	492,30	6,22	20,31	,2062
100 + 20	,98090	—	418,45	512,36	6,09	19,52	,1981
19	,98146	—	440,48	534,51	5,97	18,71	,1899
18	,98206	—	464,94	559,14	5,80	17,88	,1816
17	,98269	—	492,30	586,63	5,67	17,05	,1731
16	,98334	—	523,06	617,55	5,51	16,19	,1644
100 + 15	,98403	—	557,93	652,59	5,34	15,33	,1556
14	98475	—	597,79	692,62	5,17	14,43	,1466
13	,98550	—	643,77	738,79	4,98	13,54	,1375
12	98630	—	697,42	792,62	4,80	12,62	,1281
11	,98715	—	760,83	856,23	4,60	11,68	,1186
100 + 10	,98804	—	836,90	932,54	4,36	10,72	,1089
9	,98898	—	929,90	1025,75	4,15	9,75	,0990
8	98999	—	1046,13	1142,23	3,90	8,75	,0889
7	99106	—	1195,59	1291,92	3,67	7,74	,0786
6	,99220	—	1394,86	1491,43	3,43	6,70	,0681
100 + 5	99340	—	1673,83	1770,67	3,16	5,64	,0573
4	,99471	—	2092,26	2189,41	2,85	4,56	,0464
3	,99610	—	2789,69	2887,10	2,59	3 46	,0352
2	99759	—	4184,53	4282,19	2,34	2,34	,0237
1	,99918	—	8369 04	8466,95	2,09	1,18	,0120

TABLE I. **HEAT 34°.**

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83717	100	—	100,00	—	100,00	1,0147
1	,83949	—	0,84	100,72	0,12	99,28	1,0076
2	,84174	—	1,68	101,45	0,23	98,57	1,0004
3	,84395	—	2,51	102,18	0,33	97,87	,9932
4	,84608	—	3,35	102,91	0,44	97,18	,9861
100 + 5	,84815	—	4,19	103,64	0,55	96,49	,9791
6	,85017	—	5,03	104,38	0,65	95,80	,9722
7	,85213	—	5,86	105,12	0,74	95,13	,9654
8	,85405	—	6,70	105,87	0,83	94,46	,9586
9	,85593	—	7,53	106,61	0,92	93,80	,9519
100 + 10	,85774	—	8,37	107,36	1,01	93,14	,9452
11	,85954	—	9,20	108,11	1,09	92,50	,9386
12	,86131	—	10,04	108,86	1,18	91,86	,9321
13	,86302	—	10,88	109,61	1,27	91,23	,9257
14	,86470	—	11,71	110,37	1,34	90,61	,9194
100 + 15	,86635	—	12,55	111,13	1,42	89,99	,9131
16	,86794	—	13,39	111,89	1,50	89,38	,9069
17	,86951	—	14,22	112,64	1,58	88,77	,9008
18	,87105	—	15,06	113,40	1,66	88,17	,8948
19	,87255	—	15,89	114,16	1,73	87,58	,8888
100 + 20	,87402	—	16,73	114,93	1,80	87,00	,8829
21	,87547	—	17,56	115,69	1,87	86,42	,8770
22	,87690	—	18,40	116,46	1,94	85,85	,8712
23	,87831	—	19,24	117,23	2 01	85,30	,8656
24	,87969	—	20,08	118,00	2,08	84,74	,8599
100 + 25	,88104	—	20,92	118,76	2,16	84,19	,8543
26	,88237	—	21,74	119,54	2,20	83,65	,8489
27	,88368	—	22,58	120,31	2,27	83,11	,8435
28	,88495	—	23,42	121,08	2,34	82,58	,8381
29	,88621	—	24,26	121,85	2,41	82,06	,8328
100 + 30	,88745	—	25,09	122,64	2,45	81,54	,8275
31	,88867	—	25,93	123,41	2,52	81,03	,8223
32	,88988	—	26,77	124,18	2,59	80,53	,8172
33	,89107	—	27,61	124,96	2,65	80,03	,8121
34	,89223	—	28,44	125,73	2,71	79,53	,8071
100 + 35	,89337	—	29,28	126,51	2,77	79,04	,8021
36	,89451	—	30,12	127,29	2,83	78,56	,7972
37	,89561	—	30,95	128,06	2,89	78,08	,7924
38	,89670	—	31,79	128,83	2,96	77,61	,7876
39	,88777	—	32,62	129,62	3,00	77,14	,7829
100 + 40	,89882	—	33,46	130,40	3,06	76,68	,7782
41	,89986	—	34,30	131,18	3,12	76,23	,7736
42	,90089	—	35,13	131,96	3,17	75,78	,7690
43	,90190	—	35,97	132,74	3,23	75,34	,7645
44	,90290	—	36,80	133,52	3,28	74,89	,7600
100 + 45	,90388	—	37,64	134,30	3,34	74,46	,7556
46	,90484	—	38,47	135,08	3,39	74,03	,7513
47	,90579	—	39,31	135,86	3,45	73,60	,7469
48	,90672	—	40,15	136,65	3,50	73,18	,7427
49	,90764	—	40,98	137,43	3,55	72,76	,7384

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of Bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90853	100	41,82	138,22	3,60	72,35	,7342
51	,90943	—	42,65	139,00	3,65	71,94	,7301
52	,91029	—	43,49	139,79	3,70	71,53	,7259
53	,91115	—	44,33	140,58	3,75	71,13	,7219
54	,91200	—	45,17	141,37	3,80	70,74	,7179
100 + 55	,91283	—	46,01	142,15	3,86	70,35	,7138
56	,91365	—	46,84	142,94	3,90	69,96	,7100
57	,91446	—	47,67	143,73	3,94	69,57	,7061
58	,91525	—	48,51	144,52	3,99	69,19	,7021
59	,91603	—	49,34	145,31	4,03	68,82	,6983
100 + 60	,91681	—	50,18	146,10	4,08	68,44	,6945
61	,91758	—	51,02	146,89	4,13	68,07	,6908
62	,91833	—	51,86	147,68	4,18	67,71	,6871
63	,91907	—	52,69	148,47	4,22	67,35	,6834
64	,91979	—	53,53	149,27	4,26	66,99	,6798
100 + 65	,92051	—	54,37	150,06	4,31	66,64	,6763
66	,92122	—	55,20	150,85	4,35	66,29	,6727
67	,92192	—	56,04	151,65	4,39	65,94	,6692
68	,92261	—	56,88	152,44	4,44	65,60	,6657
69	,92329	—	57,71	153,23	4,48	65,26	,6622
100 + 70	,92397	—	58,55	154,03	4,52	64,92	,6588
71	,92464	—	59,38	154,82	4,56	64,59	,6554
72	,92530	—	60,22	155,62	4,60	64,26	,6521
73	,92593	—	61,05	156,41	4,64	63,93	,6488
74	,92657	—	61,90	157,21	4,69	63,61	,6455
100 + 75	,92722	—	62,73	158,00	4,73	63,29	,6422
76	,92785	—	63,56	158,80	4,76	62,97	,6390
77	,92846	—	64,41	159,60	4,81	62,65	,6358
78	,92908	—	65,23	160,39	4,84	62,34	,6327
79	,92968	—	66,07	161,19	4,88	62,04	,6295
100 + 80	,93027	—	66,92	161,98	4,94	61,73	,6265
81	,93086	—	67,74	162,77	4,97	61,43	,6234
82	,93144	—	68,58	163,57	5,01	61,13	,6204
83	,93202	—	69,42	164,37	5,05	60,83	,6173
84	,93259	—	70,26	165,17	5,09	60,54	,6143
100 + 85	,93314	—	71,10	165,97	5,13	60,25	,6114
86	,93369	—	71,93	166,77	5,16	59,96	,6085
87	,93423	—	72,77	167,57	5,20	59,68	,6056
88	,93476	—	73,60	168,37	5,23	59,39	,6027
89	,93529	—	74,44	169,17	5,27	59,11	,5998
100 + 90	,93581	—	75,28	169,97	5,31	58,83	,5970
91	,93632	—	76,11	170,78	5,33	58,55	,5942
92	,93682	—	76,95	171,58	5,37	58,28	,5914
93	,93732	—	77,78	172,38	5,40	58,01	,5887
94	,93781	—	78,62	173,18	5,44	57,74	,5860
100 + 95	,93830	—	79,46	173,98	5,48	57,47	,5833
96	,93878	—	80,28	174,78	5,50	57,22	,5806
97	,93925	—	81,12	175,58	5,54	56,95	,5780
98	,93972	—	81,95	176,38	5,57	56,69	,5754
99	,94019	—	82,80	177,19	5,61	56,44	,5728

TABLE II. **HEAT 34°.**

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,94065	100	83,64	178,00	5,64	56,17	,5701	100 + 50	,96607	100	167,28	259,96	7,32	38,46	,3903
99	,94110	—	84,49	178,82	5,67	55,92	,5674	49	,96660	—	170,70	263,37	7,33	37,97	,3853
98	,94154	—	85,30	179,66	5,70	55,66	,5648	48	,96711	—	174,25	266,90	7,35	37,47	,3802
97	,94199	—	86,23	180,51	5,72	55,39	,5621	47	,96764	—	177,96	270,59	7,37	36,96	,3751
96	,94244	—	87,14	181,37	5,77	55,13	,5595	46	,96815	—	181,83	274,44	7,39	36,44	,3698
100 + 95	,94289	—	88,05	182,25	5,80	54,86	,5568	100 + 45	,96865	—	185,87	278,48	7,39	35,91	,3644
94	,94335	—	88,98	183,16	5,82	54,59	,5540	44	,96915	—	190,09	282,70	7,39	35,37	,3589
93	,94381	—	89,84	184,07	5,87	54,33	,5512	43	,96965	—	194,52	287,12	7,40	34,82	,3534
92	,94427	—	90,92	185,02	5,90	54,05	,5484	42	,97013	—	199,15	291,76	7,39	34,27	,3478
91	,94475	—	91,92	186,00	5,92	53,77	,5456	41	,97062	—	204,00	296,62	7,38	33,71	,3421
100 + 90	,94522	—	92,94	186,98	5,96	53,48	,5427	100 + 40	,97110	—	209,10	301,73	7,37	33,14	,3363
89	,94571	—	93,98	187,99	5,99	53,19	,5399	39	,97156	—	214,47	307,11	7,36	32,56	,3304
88	,94621	—	95,04	189,02	6,02	52,91	,5369	38	,97202	—	220,11	312,78	7,33	31,97	,3245
87	,94671	—	96,14	190,08	6,06	52,61	,5339	37	,97248	—	226,06	318,77	7,29	31,37	,3184
86	,94721	—	97,26	191,16	6,10	52,32	,5309	36	,97294	—	232,34	325,09	7,25	30,76	,3122
100 + 85	,94771	—	98,41	192,26	6,15	52,01	,5278	100 + 35	,97339	—	238,98	331,74	7,24	30,14	,3059
84	,94822	—	99,58	193,40	6,18	51,71	,5247	34	,97385	—	246,01	338,80	7,21	29,52	,2995
83	94873	—	100,77	194,56	6,21	51,40	,5216	33	,97432	—	253,46	346,31	7,15	28,88	,2930
82	,94923	—	102,00	195,75	6,25	51,08	,5184	32	,97478	—	261,38	354,28	7,10	28,23	,2864
81	,94974	—	103,26	196,97	6,29	50,77	,5152	31	,97525	—	269,82	362,77	7,05	27,57	,2797
100 + 80	,95025	—	104,55	198,23	6,32	50,45	,5119	100 + 30	,97572	—	278,80	371,80	7,00	26,90	,2729
79	,95077	—	105,88	199,51	6,37	50,12	,5086	29	,97619	—	288,42	381,47	6,95	26,21	,2660
78	,95128	—	107,24	200,83	6,41	49,79	,5052	28	97667	—	298,73	391,85	6,88	25,52	,2590
77	,95180	—	108,63	202,19	6,44	49,46	,5018	27	,97715	—	309,79	402,99	6,80	24,81	,2518
76	,95231	—	110,07	203,58	6,49	49,12	,4984	26	,97763	—	321,70	414,99	6,71	24,10	,2445
100 + 75	,95283	—	111,53	205,01	6,52	48,78	,4950	100 + 25	,97813	—	334,58	427,95	6,63	23,37	,2371
74	,95334	—	113,02	206,49	6,53	48,43	,4915	24	,97864	—	348,51	441,97	6,54	22,62	,2296
73	,95485	—	114,57	207,99	6,58	48,08	,4879	23	,97916	—	363,66	457,23	6,43	21,87	,2219
72	,95436	—	116,17	209,55	6,62	47,72	,4843	22	,97970	—	381,18	473,87	6,31	21,10	,2141
71	,95486	—	117,80	211,15	6,64	47,36	,4806	21	,98026	—	398,30	492,07	6,23	20,32	,2062
100 + 70	,95538	—	119,48	212,80	6,68	46,99	,4768	100 + 20	,98083	—	418,21	512,12	6,09	19,53	,1981
69	,95591	—	121,21	214,50	6,71	46,62	,4730	19	,98141	—	440,23	534,26	5,97	18,72	,1899
68	,95645	—	123,00	216,24	6,76	46,24	,4693	18	,98201	—	464,68	558,87	5,81	17,89	,1816
67	,95698	—	124,84	218,05	6,79	45,86	,4654	17	,98265	—	492,02	586,34	5,68	17,06	,1731
66	,95752	—	126,73	219,90	6,83	45,47	,4615	16	,98331	—	522,77	617,24	5,53	16,20	,1644
100 + 65	,95806	—	128,68	221,81	6,87	45,08	,4575	100 + 15	,98400	—	557,62	652,26	5,36	15,33	,1556
64	,95861	—	130,69	223,79	6,90	44,69	,4535	14	,98473	—	597,45	692,27	5,18	14,44	,1466
63	,95916	—	132,76	225,82	6,94	44,28	,4494	13	,98549	—	643,41	738,41	5,00	13,54	,1374
62	,95971	—	134,90	227,92	6,98	43,87	,4451	12	,98629	—	697,03	792,21	4,82	12,62	,1281
61	,96026	—	137,11	230,10	7,01	43,46	,4409	11	98714	—	760,40	855,78	4,62	11,69	,1186
100 + 60	,96080	—	139,40	232,36	7,04	43,04	,4367	100 + 10	98804	—	836,43	932,04	4,39	10,73	,1089
59	,96134	—	141,76	234,68	7,08	42,61	,4324	9	,98898	—	929,37	1025,20	4,17	9,75	,0990
58	,96187	—	144,20	237,09	7,11	42,18	,4280	8	99000	—	1045,54	1141,61	3,93	8,76	,0889
57	,96241	—	146,74	239,60	7,14	41,74	,4235	7	99107	—	1194,91	1291,21	3,70	7,74	,0786
56	,96294	—	149,36	242,19	7,17	41,29	,4191	6	,99221	—	1394,07	1490,61	3,46	6,71	,0681
100 + 55	,96346	—	152,07	244,87	7,20	40,8	,4144	100 + 5	99342	—	1672,88	1769,69	3,19	5,65	,0573
54	96399	—	154,86	247,65	7,21	40,38	,4098	4	,99473	—	2091,08	2188,19	2,89	4,57	,0464
53	,96451	—	157,78	250,55	7,23	39,91	,4050	3	99612	—	2788,10	2885,49	2,61	3,46	,0352
52	,96504	—	160,82	253,57	7,25	39,44	,4002	2	,99761	—	4182,17	4279,81	2,36	2,34	,0237
51	,96555	—	163,99	256,70	7,29	38,95	,3953	1	,99920	—	8364,32	8464,24	2,08	1,18	0120

TABLE I. HEAT 35°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83672	100	0,84	100,00	—	100,00	1,0142
1	,83904	—	0,84	100,72	0,12	99,28	1,0070
2	,84129	—	1,67	101,45	0,22	98,57	,9998
3	,84349	—	2,51	102,18	0,33	97,87	,9926
4	,84562	—	3,34	102,91	0,43	97,18	,9855
100 + 5	,84769	—	4,18	103,64	0,54	96,49	,9786
6	,84971	—	5,02	104,38	0,64	95,80	,9716
7	,85167	—	5,85	105,12	0,73	95,13	,9648
8	,85359	—	6,69	105,87	0,82	94,46	,9580
9	,85547	—	7,52	106,61	0,91	93,80	,9513
100 + 10	,85729	—	8,36	107,36	1,00	93,14	,9447
11	,85908	—	9,20	108,11	1,09	92,50	,9381
12	,86083	—	10,03	108,86	1,17	91,86	,9316
13	,86255	—	10,87	109,61	1,26	91,23	,9252
14	,86423	—	11,70	110,37	1,33	90,61	,9189
100 + 15	,86587	—	12,54	111,13	1,41	89,99	,9126
16	,86747	—	13,38	111,89	1,49	89,38	,9064
17	,86904	—	14,21	112,65	1,56	88,77	,9003
18	,87058	—	15,05	113,41	1,64	88,17	,8943
19	,87209	—	15,88	114,17	1,71	87,58	,8883
200 + 20	,87357	—	16,72	114,94	1,78	87,00	,8824
21	,87502	—	17,55	115,70	1,85	86,43	,8766
22	,87645	—	18,39	116,46	1,93	85,86	,8708
23	,87786	—	19,23	117,23	2,00	85,30	,8651
24	,87924	—	20,06	118,00	2,06	84,74	,8595
100 + 25	,88059	—	20,90	118,77	2,13	84,19	,8539
26	,88192	—	21,73	119,54	2,19	83,65	,8484
27	,88323	—	22,57	120,31	2,26	83,12	,8430
28	,88451	—	23,41	121,08	2,33	82,59	,8376
29	,88577	—	24,24	121,85	2,39	82,06	,8323
100 + 30	,88701	—	25,08	122,63	2,45	81,54	,8270
31	,88823	—	25,91	123,40	2,51	81,04	,8218
32	,88944	—	26,75	124,18	2,57	80,53	,8167
33	,89063	—	27,59	124,95	2,64	80,03	,8117
34	,89179	—	28,42	125,73	2,69	79,54	,8067
100 + 35	,89294	—	29,26	126,50	2,76	79,05	,8017
36	,89407	—	30,10	127,28	2,82	78,57	,7968
37	,89517	—	30,93	128,05	2,88	78,09	,7920
38	,89626	—	31,77	128,83	2,94	77,62	,7872
39	,89733	—	32,60	129,61	2,99	77,15	,7825
100 + 40	,89839	—	33,44	130,39	3,05	76,69	,7778
41	,89943	—	34,27	131,17	3,10	76,24	,7732
42	,90046	—	35,11	131,95	3,16	75,79	,7686
43	,90147	—	35,95	132,73	3,22	75,34	,7641
44	,90247	—	36,78	133,51	3,27	74,90	,7596
100 + 45	,90345	—	37,62	134,29	3,33	74,47	,7552
46	,90441	—	38,45	135,07	3,38	74,04	,7509
47	,90536	—	39,29	135,86	3,43	73,61	,7466
48	,90629	—	40,13	136,64	3,49	73,19	,7423
49	,90721	—	40,96	137,42	3,54	72,77	,7380

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90811	100	41,80	138,21	3,59	72,35	,7338
51	,90900	—	42,63	138,99	3,64	71,94	,7297
52	,90987	—	43,47	139,78	3,69	71,54	,7256
53	,91073	—	44,30	140,57	3,73	71,14	,7215
54	,91158	—	45,14	141,36	3,78	70,74	,7175
100 + 55	,91241	—	45,98	142,14	3,84	70,35	,7135
56	,91323	—	46,81	142,93	3,88	69,96	,7096
57	,91404	—	47,65	143,72	3,93	69,58	,7057
58	,91483	—	48,49	144,51	3,98	69,20	,7018
59	,91561	—	49,32	145,30	4,02	68,82	,6980
100 + 60	,91640	—	50,16	146,09	4,07	68,45	,6942
61	,91716	—	50,99	146,88	4,11	68,08	,6905
62	,91791	—	51,83	147,67	4,16	67,72	,6868
63	,91865	—	52,67	148,46	4,21	67,36	,6831
64	,91937	—	53,50	149,26	4,24	67,00	,6795
100 + 65	,92009	—	54,34	150,05	4,29	66,65	,6760
66	,92080	—	55,17	150,84	4,33	66,30	,6724
67	,92150	—	56,01	151,64	4,37	65,95	,6689
68	,92219	—	56,85	152,43	4,42	65,60	,6654
69	,92287	—	57,68	153,22	4,46	65,26	,6619
100 + 70	,92355	—	58,52	154,02	4,50	64,93	,6585
71	,92422	—	59,35	154,81	4,54	64,60	,6551
72	,92488	—	60,19	155,61	4,58	64,27	,6518
73	,92552	—	61,02	156,40	4,62	63,94	,6485
74	,92616	—	61,86	157,20	4,66	63,62	,6452
100 + 75	,92680	—	62,70	157,99	4,71	63,30	,6419
76	,92743	—	63,53	158,79	4,74	62,98	,6387
77	,92805	—	64,37	159,59	4,78	62,66	,6355
78	,92866	—	65,20	160,38	4,82	62,35	,6324
79	,92926	—	66,04	161,18	4,86	62,05	,6293
100 + 80	,92986	—	66,88	161,97	4,91	61,74	,6262
81	,93045	—	67,71	162,76	4,95	61,44	,6231
82	,93103	—	68,55	163,56	4,99	61,14	,6201
83	,93161	—	69,38	164,36	5,02	60,84	,6170
84	,93218	—	70,22	165,16	5,06	60,55	,6140
100 + 85	,93274	—	71,06	165,95	5,11	60,26	,6111
86	,93329	—	71,89	166,75	5,14	59,97	,6082
87	,93383	—	72,73	167,55	5,18	59,68	,6053
88	,93436	—	73,56	168,35	5,21	59,40	,6024
89	,93489	—	74,40	169,15	5,25	59,12	,5995
100 + 90	,93541	—	75,24	169,95	5,29	58,84	,5967
91	,93592	—	76,07	170,76	5,31	58,56	,5939
92	,93642	—	76,91	171,56	5,35	58,29	,5911
93	,93692	—	77,74	172,36	5,38	58,02	,5884
94	,93741	—	78,58	173,16	5,42	57,75	,5857
100 + 95	,93790	—	79,42	173,96	5,46	57,48	,5830
96	,93838	—	80,24	174,76	5,48	57,22	,5803
97	,93885	—	81,07	175,56	5,51	56,96	,5777
98	,93932	—	81,91	176,36	5,55	56,70	,5751
99	,93979	—	82,75	177,17	5,58	56,44	,5725

TABLE II. HEAT 35°.

I. Water and spirit by weight.	II. Specific gravity.	III Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,94025	100	83,60	177,98	5,62	56,18	,5698
99	,94070	—	84,45	178,80	5,65	55,93	,5672
98	,94115	—	85,31	179,64	5,67	55,67	,5646
97	,94159	—	86,19	180,49	5,70	55,40	,5619
96	,94204	—	87,09	181,35	5,74	55,14	,5593
100 + 95	,94249	—	88,00	182,23	5,77	54,87	,5566
94	,94295	—	88,93	183,13	5,80	54,60	,5538
93	,94342	—	89,89	184,05	5,84	54,33	,5510
92	,94389	—	90,87	185,00	5,87	54,05	,5482
91	,94436	—	91,87	185,97	5,90	53,77	,5454
100 + 90	,94484	—	92,89	186,95	5,94	53,49	,5425
89	,94533	—	93,93	187,96	5,97	53,20	,5396
88	,94583	—	94,99	188,99	6,00	52,91	,5367
87	,94633	—	96,09	190,05	6,04	52,62	,5337
86	,94683	—	97,21	191,13	6,08	52,32	,5307
100 + 85	,94734	—	98,35	192,23	6,12	52,02	,5276
84	,94785	—	99,52	193,37	6,15	51,71	,5245
83	,94835	—	100,72	194,53	6,19	51,40	,5214
82	,94886	—	101,95	195,72	6,23	51,09	,5182
81	,94937	—	103,20	196,94	6,26	50,78	,5150
100 + 80	,94988	—	104,49	198,20	6,29	50,46	,5117
79	,95040	—	105,82	199,48	6,34	50,13	,5084
78	,95091	—	107,18	200,80	6,38	49,80	,5051
77	,95143	—	108,57	202,16	6,41	49,47	,5017
76	,95194	—	110,00	203,55	6,45	49,13	,4983
100 + 75	,95246	—	111,46	204,98	6,48	48,79	,4948
74	,95297	—	112,96	206,45	6,51	48,44	,4913
73	,95348	—	114,51	207,96	6,55	48,09	,4877
72	,95399	—	116,10	209,52	6,58	47,73	,4841
71	,95450	—	117,74	211,13	6,61	47,37	,4804
100 + 70	,95502	—	119,42	212,77	6,65	47,00	,4767
69	,95555	—	121,15	214,46	6,69	46,63	,4729
68	,95609	—	122,93	216,21	6,72	46,25	,4691
67	,95663	—	124,77	218,01	6,76	45,87	,4652
66	,95717	—	126,66	219,86	6,80	45,48	,4613
100 + 65	,95772	—	128,61	221,77	6,84	45,09	,4573
64	,95827	—	130,62	223,74	6,88	44,70	,4533
63	,95882	—	132,69	225,77	6,92	44,29	,4492
62	,95938	—	134,83	227,88	6,95	43,88	,4450
61	,95993	—	137,04	230,06	6,98	43,47	,4408
100 + 60	,96048	—	139,32	232,31	7,01	43,05	,4366
59	,96102	—	141,68	234,63	7,05	42,62	,4322
58	,96155	—	144,12	237,04	7,08	42,19	,4278
57	,96209	—	146,66	239,55	7,11	41,75	,4234
56	,96262	—	149,28	242,14	7,14	41,30	,4189
100 + 55	,96315	—	151,99	244,82	7,17	40,85	,4143
54	,96368	—	154,78	247,60	7,18	40,39	,4096
53	,96421	—	157,69	250,50	7,19	39,92	,4049
52	,96474	—	160,73	253,51	7,22	39,45	,4001
51	,96526	—	163,90	256,65	7,25	38,96	,3952

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96579	100	167,19	259,91	7,28	38,47	,3902
49	,96632	—	170,61	263,30	7,31	37,98	,3852
48	,96684	—	174,16	266,83	7,33	37,48	,3801
47	,96737	—	177,86	270,52	7,34	36,97	,3750
46	,96789	—	181,73	274,37	7,36	36,45	,3697
100 + 45	,96840	—	185,77	278,40	7,37	35,92	,3643
44	,96890	—	189,99	282,62	7,37	35,38	,3588
43	,96940	—	194,41	287,04	7,37	34,83	,3533
42	,96989	—	199,04	291,67	7,37	34,28	,3477
41	,97038	—	203,89	296,53	7,36	33,72	,3420
100 + 40	,97086	—	208,99	301,64	7,35	33,15	,3362
39	,97133	—	214,35	307,02	7,33	32,57	,3303
38	,97180	—	219,99	312,69	7,30	31,98	,3244
37	,97226	—	225,94	318,67	7,27	31,38	,3183
36	,97273	—	232,21	324,98	7,23	30,77	,3121
100 + 35	,97319	—	238,85	331,63	7,22	30,15	,3058
34	,97366	—	245,87	338,68	7,19	29,53	,2995
33	,97413	—	253,32	346,19	7,13	28,89	,2930
32	,97460	—	261,24	354,16	7,08	28,24	,2864
31	,97508	—	269,67	362,63	7,04	27,58	,2797
100 + 30	,97556	—	278,65	371,66	6,99	26,91	,2729
29	,97603	—	288,26	381,33	6,93	26,22	,2660
28	,97652	—	298,56	391,70	6,86	25,53	,2590
27	,97701	—	309,62	402,84	6,78	24,82	,2518
26	,97750	—	321,52	414,83	6,69	24,11	,2445
100 + 25	,97801	—	334,39	427,77	6,62	23,38	,2371
24	,97853	—	348,32	441,79	6,53	22,63	,2296
23	,97906	—	363,46	457,03	6,43	21,88	,2219
22	,97961	—	379,97	473,66	6,31	21,11	,2141
21	,98018	—	398,08	491,85	6,23	20,33	,2062
100 + 20	,98076	—	417,98	511,88	6,10	19,54	,1981
19	,98135	—	439,98	534,01	5,97	18,73	,1899
18	,98196	—	464,42	558,59	5,83	17,90	,1816
17	,98260	—	491,74	586,06	5,68	17,06	,1731
16	,98327	—	522,48	616,94	5,54	16,21	,1644
100 + 15	,98397	—	557,31	651,94	5,37	15,34	,1556
14	,98470	—	597,12	691,92	5,20	14,45	,1466
13	,98547	—	643,05	738,03	5,02	13,55	,1374
12	,98628	—	696,64	791,80	4,84	12,63	,1281
11	,98714	—	759,97	855,33	4,64	11,69	,1186
100 + 10	,98804	—	835,96	931,55	4,41	10,73	,1089
9	,98899	—	928,85	1024,65	4,20	9,76	,0990
8	,99000	—	1044,95	1140,99	3,96	8,77	,0889
7	,99108	—	1194,23	1290,51	3,72	7,75	,0786
6	,99222	—	1393,28	1489,79	3,49	6,71	,0681
100 + 5	,99344	—	1671,93	1768,71	3,22	5,65	,0573
4	,99474	—	2089,91	2186,98	2,93	4,57	,0464
3	,99613	—	2786,55	2883,90	2,65	3,47	,0352
2	,99762	—	4179,82	4277,44	2,38	2,34	,0237
1	,99921	—	8359,64	8457,55	2,09	1,18	,0120

TABLE I. HEAT 36°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83627	100	—	100,00	—	100,00	1,0137
1	,83858	—	0,84	100,72	0,12	99,28	1,0065
2	,84082	—	1,67	101,45	0,22	98,57	,9993
3	,84303	—	2,51	102,18	0,33	97,87	,9921
4	,84516	—	3,34	102,91	0,43	97,18	,9850
100 + 5	,84723	—	4,18	103,64	0,54	96,49	,9780
6	,84926	—	5,02	104,38	0,64	95,80	,9711
7	,85122	—	5,85	105,12	0,73	95,13	,9643
8	,85314	—	6,69	105,87	0,82	94,46	,9575
9	,85502	—	7,52	106,61	0,91	93,80	,9508
100 + 10	,85684	—	8,36	107,36	1,00	93,14	,9442
11	,85863	—	9,19	108,11	1,08	92,50	,9377
12	,86038	—	10,02	108,86	1,16	91,86	,9312
13	,86210	—	10,86	109,61	1,25	91,23	,9248
14	,86378	—	11,69	110,37	1,32	90,61	,9185
100 + 15	,86541	—	12,53	111,13	1,40	89,99	,9122
16	,86701	—	13,37	111,89	1,48	89,38	,9060
17	,86859	—	14,20	112,64	1,56	88,77	,8999
18	,87013	—	15,04	113,41	1,63	88,17	,8939
19	,87164	—	15,87	114.17	1,70	87,59	,8879
100 + 20	,87313	—	16,71	114,94	1,77	87,01	,8819
21	,87458	—	17,54	115,70	1,84	86,43	,8761
22	,87601	—	18,38	116,46	1,92	85,86	,8703
23	,87742	—	19,22	117,23	1,99	85,30	,8647
24	,87880	—	20,05	117,99	2,06	84,74	,8591
100 + 25	,88015	—	20,89	118,77	2,12	84,19	,8535
26	,88148	—	21,72	119,53	2,19	83,65	,8480
27	,88279	—	22,56	120,30	2,26	83,12	,8426
28	,88407	—	23,40	121,08	2,32	82,59	,8372
29	,88533	—	24,23	121.85	2,38	82,06	,8319
100 + 30	,88657	—	25,07	122,63	2,44	81,55	,8266
31	,88779	—	25,90	123,40	2,50	81,04	,8214
32	,88900	—	26,74	124,18	2,56	80,53	,8163
33	,89019	—	27,58	124,95	2,63	80,03	,8113
34	,89135	—	28,41	125,72	2,69	79,54	,8063
100 + 35	,89250	—	29,24	126,50	2,74	79,05	,8013
36	,89363	—	30,08	127,27	2,81	78,57	,7965
37	,89473	—	30,91	128,05	2,86	78,09	,7917
38	,89582	—	31,75	128,82	2,93	77,62	,7869
39	,89689	—	32,58	129,60	2,98	77,15	,7821
100 + 40	,89795	—	33,42	130,38	3,04	76,69	,7775
41	,89899	—	34,25	131,16	3,09	76,24	,7728
42	,90002	—	35,09	131,94	3,15	75,79	,7683
43	,90103	—	35,93	132,72	3,21	75,34	,7638
44	,90204	—	36,76	133,50	3,26	74,90	,7593
100 + 45	,90302	—	37,60	134,28	3,32	74,47	,7549
46	,90397	—	38,43	135,06	3,37	74,04	,7505
47	,90493	—	39,27	135,85	3,42	73,61	,7463
48	,90586	—	40,10	136,63	3,47	73,19	,7420
49	,90678	—	40,94	137,41	3,53	72,77	,7377

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90768	100	41,78	138,20	3,58	72,36	,7335
51	,90857	—	42,61	138,98	3,63	71,95	,7294
52	,90944	—	43,44	139,77	3,67	71,55	,7253
53	,91030	—	44,28	140,56	3,72	71,15	,7212
54	,91115	—	45,12	141,34	3,78	70,75	,7172
100 + 55	,91198	—	45,96	142,13	3,83	70,36	,7132
56	,91280	—	46,78	142,92	3,86	69,97	,7093
57	,91362	—	47,62	143,71	3,91	69,59	,7054
58	,91441	—	48,46	144,49	3,97	69,21	,7015
59	,91519	—	49,29	145,28	4,01	68,83	,6977
100 + 60	,91598	—	50,13	146,07	4,06	68,46	,6939
61	,91674	—	50,96	146,86	4,10	68,09	,6902
62	,91748	—	51,80	147,66	4,14	67,72	,6865
63	,91823	—	52,64	148,44	4,20	67,37	,6828
64	,91895	—	53,47	149,24	4,23	67,00	,6792
100 + 65	,91967	—	54,31	150,03	4,28	66,65	,6756
66	,92039	—	55,14	150,82	4,32	66,30	,6721
67	,92109	—	55,98	151,62	4,36	65,96	,6686
68	,92178	—	56,81	152,41	4,40	65,61	,6651
69	,92246	—	57,64	153.20	4,44	65,27	,6616
100 + 70	,92315	—	58,48	154,00	4,48	64,93	,6582
71	,92381	—	59,31	154,80	4,51	64,61	,6549
72	,92447	—	60,15	155,59	4,56	64,27	,6515
73	,92511	—	60,98	156,38	4,60	63,94	,6482
74	,92576	—	61,82	157.18	4,64	63,62	,6449
100 + 75	,92640	—	62,66	157,97	4,69	63,31	,6416
76	,92702	—	63,50	158,77	4,73	62,98	,6384
77	,92764	—	64,33	159,57	4,76	62,67	,6352
78	,92825	—	65,16	160,36	4,80	62,36	,6321
79	,92885	—	66,00	161.16	4,84	62,05	,6291
100 + 80	,92946	—	66,84	161,95	4,89	61,75	,6259
81	,93005	—	67,67	162.74	4,93	61,45	,6229
82	,93063	—	68,51	163.54	4,97	61,14	,6199
83	,93121	—	69,34	164,35	4,99	60,84	,6168
84	,93178	—	70,18	165,14	5,04	60,56	,6138
100 + 85	,93234	—	71,02	165,94	5,08	60,26	,6109
86	,93289	—	71,85	166,74	5,11	59,97	,6080
87	,93343	—	72,69	167,54	5,15	59,69	,6051
88	,93397	—	73,52	168,34	5,18	59,40	,6022
89	,93450	—	74,36	169,14	5,22	59,12	,5993
100 + 90	,93501	—	75,20	169,94	5,26	58,85	,5965
91	,93553	—	76,02	170,74	5,28	58,57	,5937
92	,93603	—	76,86	171,54	5,32	58,29	,5909
93	,93653	—	77,70	172,35	5,35	58,02	,5882
94	,93702	—	78,53	173.15	5,38	57,75	,5855
100 + 95	,93751	—	79,37	173,94	5,43	57,49	,5827
96	,93799	—	80,19	174,74	5,45	57,23	,5801
97	,93846	—	81,02	175,54	5,48	56,97	,5775
98	,93893	—	81,86	176,34	5,52	56,70	,5749
99	,93939	—	82,70	177,14	5,56	56,45	,5722

TABLE II.

HEAT 36°.

I. Water and Spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93986	100	83,55	177,95	5,60	56,19	,5696
99	,94030	—	84,40	178,77	5,63	55,93	,5669
98	,94076	—	85,26	179,61	5,65	55,67	,5643
97	,94120	—	86,14	180,46	5,68	55,41	,5617
96	,94165	—	87,04	181,32	5,72	55,15	,5591
100 + 95	,94210	—	87,95	182,20	5,75	54,88	,5563
94	,94257	—	88,88	183,11	5,77	54,61	,5536
93	,94304	—	89,84	184,02	5,82	54,34	,5508
92	,94351	—	90,82	184,97	5,85	54,06	,5480
91	,94398	—	91,81	185,94	5,87	53,78	,5452
100 + 90	,94446	—	92,84	186,92	5,92	53,50	,5423
89	,94496	—	93,87	187,94	5,93	53,21	,5394
88	,94546	—	94,94	188,96	5,98	52,92	,5365
87	,94596	—	96,04	190,03	6,01	52,63	,5335
86	,94646	—	97,15	191,11	6,04	52,33	,5305
100 + 85	,94696	—	98,30	192,21	6,09	52,03	,5274
84	,94748	—	99,46	193,34	6,12	51,72	,5243
83	,94798	—	100,66	194,50	6,16	51,41	,5212
82	,94849	—	101,89	195,69	6,20	51,09	,5180
81	,94900	—	103,14	196,91	6,23	50,79	,5148
100 + 80	,94950	—	104,43	198,17	6,26	50,47	,5115
79	,95003	—	105,76	199,45	6,31	50,13	,5082
78	,95054	—	107,12	200,77	6,35	49,80	,5049
77	,95106	—	108,51	202,13	6,38	49,47	,5015
76	,95157	—	109,94	203,52	6,42	49,13	,4981
100 + 75	,95208	—	111,39	204,94	6,45	48,79	,4946
74	,95261	—	112,89	206,41	6,48	48,45	,4911
73	,95312	—	114,44	207,92	6,52	48,09	,4875
72	,95364	—	116,03	209,48	6,55	47,73	,4839
71	,95415	—	117,67	211,09	6,58	47,38	,4803
100 + 70	,95468	—	119,35	212,73	6,62	47,01	,4765
69	,95521	—	121,08	214,42	6,66	46,64	,4728
68	,95575	—	122,86	216,17	6,69	46,26	,4690
67	,95629	—	124,70	217,97	6,73	45,88	,4651
66	,95683	—	126,59	219,82	6,77	45,49	,4612
100 + 65	,95738	—	128,54	221,73	6,81	45,10	,4572
64	,95793	—	130,54	223,70	6,84	44,70	,4532
63	,95848	—	132,61	225,73	6,88	44,29	,4491
62	,95904	—	134,75	227,84	6,91	43,89	,4449
61	,95959	—	136,96	230,01	6,95	43,48	,4407
100 + 60	,96014	—	139,24	232,26	6,98	43,05	,4364
59	,96069	—	141,60	234,59	7,01	42,63	,4321
58	,96123	—	144,04	236,99	7,05	42,20	,4277
57	,96177	—	146,58	239,50	7,08	41,76	,4233
56	,96231	—	149,19	242,09	7,10	41,31	,4188
100 + 55	,96283	—	151,90	244,76	7,14	40,85	,4141
54	,96338	—	154,69	247,55	7,14	40,40	,4095
53	,96391	—	157,60	250,45	7,15	39,93	,4048
52	,96445	—	160,64	253,46	7,18	39,45	,4000
51	,96497	—	163,81	256,59	7,22	38,97	,3951

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Dimi. nution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96550	100	167,09	259,85	7,24	38,48	,3901
49	,96604	—	170,51	263,23	7,28	37,99	,3851
48	,96656	—	174,06	266,76	7,30	37,48	,3800
47	,96710	—	177,76	270,45	7,31	36,98	,3749
46	,96762	—	181,63	274,30	7,33	36,46	,3696
100 + 45	,96814	—	185,66	278,33	7,33	35,92	,3642
44	,96864	—	189,88	282,54	7,34	35,39	,3588
43	,96915	—	194,30	286,96	7,34	34,84	,3533
42	,96964	—	198,93	291,59	7,34	34,29	,3477
41	,97014	—	203,77	296,44	7,33	33,73	,3420
100 + 40	,97063	—	208,87	301,55	7,32	33,16	,3361
39	,97110	—	214,23	306,92	7,31	32,58	,3303
38	,97158	—	219,86	312,59	7,27	31,99	,3243
37	,97205	—	225,81	318,56	7,25	31,39	,3182
36	,97253	—	232,08	324,86	7,22	30,78	,3121
100 + 35	,97300	—	238,71	331,52	7,19	30,16	,3058
34	,97347	—	245,73	338,56	7,17	29,54	,2994
33	,97395	—	253,18	346,06	7,12	28,90	,2929
32	,97442	—	261,09	354,03	7,06	28,25	,2863
31	,97491	—	269,52	362,50	7,02	27,59	,2796
100 + 30	,97540	—	278,49	371,52	6,97	26,92	,2728
29	,97587	—	288,10	381,18	6,92	26,23	,2659
28	,97637	—	298,39	391,55	6,84	25,54	,2589
27	,97687	—	309,44	402,67	6,77	24,83	,2518
26	,97737	—	321,34	414,66	6,68	24,11	,2445
100 + 25	,97789	—	334,20	427,59	6,61	23,39	,2371
24	,97841	—	348,12	441,60	6,52	22,64	,2296
23	,97895	—	363,26	456,83	6,43	21,89	,2219
22	,97951	—	379,76	473,45	6,31	21,12	,2141
21	,98009	—	397,86	491,63	6,23	20,34	,2062
100 + 20	,98068	—	417,75	511,64	6,11	19,54	,1981
19	,98128	—	439,73	533,76	5,97	18,73	,1899
18	,98189	—	464,16	558,32	5,84	17,91	,1816
17	,98254	—	491,47	585,77	5,70	17,07	,1731
16	,98322	—	522,19	616,64	5,55	16,21	,1644
100 + 15	,98393	—	557,00	651,61	5,39	15,34	,1556
14	,98466	—	596,79	691,57	5,22	14,46	,1466
13	,98544	—	642,69	737,65	5,04	13,56	,1374
12	,98625	—	696,25	791,39	4,86	12,63	,1281
11	,98712	—	759,55	854,88	4,67	11,70	,1186
100 + 10	,98803	—	835,50	931,05	4,45	10,74	,1089
9	,98898	—	928,33	1024,10	4,23	9,76	,0990
8	,98999	—	1044,37	1140,38	3,99	8,77	,0889
7	,99108	—	1193,57	1289,81	3,76	7,75	,0786
6	,99222	—	1392,51	1488,98	3,53	6,72	,0681
100 + 5	,99344	—	1671,01	1767,74	3,27	5,66	,0573
4	,99475	—	2088,75	2185,78	2,97	4,57	,0464
3	,99614	—	2785,00	2882,31	2,69	3,47	,0352
2	,99764	—	4177,50	4275,07	2,43	2,34	,0237
1	,99923	—	8354,99	8452,87	2,12	1,18	,0120

TABLE I. HEAT 37°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83582	100	—	100,00	—	100,00	1,0131
1	,83812	—	0,84	100,72	0,12	99,28	1,0060
2	,84036	—	1,67	101,45	0,22	98,57	,9988
3	,84256	—	2,51	102,18	0,33	97,87	,9916
4	,84470	—	3,34	102,91	0,43	97,18	,9845
100 + 5	,84677	—	4,18	103,64	0,54	96,49	,9775
6	,84880	—	5,01	104,38	0,63	95,80	,9706
7	,85077	—	5,85	105,12	0,73	95,13	,9638
8	,85269	—	6,68	105,87	0,81	94,46	,9570
9	,85458	—	7,51	106,61	0,90	93,80	,9503
100 + 10	,85639	—	8,35	107,36	0,99	93,15	,9437
11	,85818	—	9,19	108,11	1,08	92,50	,9372
12	,85993	—	10,02	108,86	1,16	91,86	,9307
13	,86165	—	10,86	109,61	1,25	91,23	,9243
14	,86333	—	11,69	110,37	1,32	90,61	,9180
100 + 15	,86496	—	12,53	111,12	1,41	89,99	,9117
16	,86656	—	13,37	111,88	1,49	89,38	,9055
17	,86814	—	14,19	112,64	1,55	88,78	,8994
18	,86968	—	15,03	113,40	1,63	88,18	,8934
19	,87120	—	15,86	114,16	1,70	87,59	,8874
100 + 20	,87268	—	16,70	114,93	1,77	87,01	,8815
21	,87413	—	17,53	115,69	1,84	86,43	,8757
22	,87556	—	18,37	116,45	1,92	85,86	,8699
23	,87697	—	19,21	117,22	1,99	85,30	,8642
24	,87835	—	20,04	117,99	2,05	84,75	,8586
100 + 25	,87971	—	20,88	118,76	2,12	84,20	,8530
26	,88103	—	21,71	119,53	2,18	83,66	,8476
27	,88235	—	22,55	120,30	2,25	83,13	,8422
28	,88363	—	23,38	121,07	2,31	82,60	,8368
29	,88489	—	24,22	121,84	2,38	82,07	,8315
100 + 30	,88613	—	25,05	122,62	2,43	81,55	,8262
31	,88735	—	25,88	123,39	2,49	81,05	,8210
32	,88856	—	26,72	124,17	2,55	80,54	,8159
33	,88975	—	27,56	124,95	2,61	80,04	,8109
34	,89091	—	28,39	125,72	2,67	79,55	,8059
100 + 35	,89205	—	29,23	126,49	2,74	79,06	,8010
36	,89318	—	30,07	127,27	2,80	78,58	,7961
37	,89429	—	30,90	128,04	2,86	78,10	,7913
38	,89538	—	31,73	128,82	2,91	77,62	,7865
39	,89645	—	32,56	129,60	2,96	77,16	,7817
100 + 40	,89750	—	33,40	130,38	3,02	76,70	,7771
41	,89855	—	34,23	131,15	3,08	76,25	,7725
42	,89958	—	35,07	131,93	3,14	75,80	,7679
43	,90059	—	35,91	132,71	3,20	75,35	,7634
44	,90160	—	36,74	133,49	3,25	74,91	,7590
100 + 45	,90259	—	37,57	134,27	3,30	74,48	,7545
46	,90353	—	38,41	135,05	3,36	74,04	,7502
47	,90450	—	39,25	135,84	3,41	73,62	,7460
48	,90543	—	40,08	136,62	3,46	73,20	,7417
49	,90635	—	40,92	137,40	3,52	72,78	,7373

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90725	100	41,75	138,19	3,56	72,36	,7331
51	,90814	—	42,58	138,97	3,61	71,95	,7291
52	,90901	—	43,42	139,76	3,66	71,55	,7249
53	,90987	—	44,25	140,55	3,70	71,15	,7208
54	,91072	—	45,09	141,33	3,76	70,75	,7169
100 + 55	,91155	—	45,93	142,12	3,81	70,36	,7129
56	,91237	—	46,76	142,91	3,85	69,97	,7090
57	,91320	—	47,59	143,70	3,89	69,59	,7051
58	,91399	—	48,43	144,48	3,95	69,21	,7012
59	,91477	—	49,26	145,27	3,99	68,83	,6974
100 + 60	,91556	—	50,10	146,06	4,04	68,46	,6936
61	,91632	—	50,93	146,85	4,08	68,09	,6899
62	,91706	—	51,77	147,65	4,12	67,73	,6862
63	,91781	—	52,61	148,43	4,18	67,37	,6825
64	,91853	—	53,44	149,23	4,21	67,01	,6789
100 + 65	,91925	—	54,28	150,02	4,26	66,66	,6753
66	,91997	—	55,11	150,81	4,30	66,31	,6718
67	,92068	—	55,95	151,61	4,34	65,96	,6683
68	,92137	—	56,78	152,40	4,38	65,61	,6648
69	,92205	—	57,61	153,19	4,42	65,27	,6614
100 + 70	,92274	—	58,45	153,99	4,46	64,94	,6579
71	,92340	—	59,28	154,78	4,50	64,61	,6546
72	,92406	—	60,11	155,58	4,53	64,28	,6512
73	,92470	—	60,95	156,37	4,58	63,95	,6479
74	,92536	—	61,79	157,17	4,62	63,63	,6446
100 + 75	,92599	—	62,63	157,96	4,67	63,31	,6414
76	,92661	—	63,46	158,75	4,71	62,99	,6382
77	,92723	—	64,29	159,55	4,74	62,67	,6349
78	,92784	—	65,13	160,34	4,79	62,36	,6318
79	,92844	—	65,97	161,14	4,83	62,06	,6288
100 + 80	,92906	—	66,80	161,93	4,87	61,75	,6256
81	,92965	—	67,63	162,73	4,90	61,45	,6226
82	,93023	—	68,47	163,53	4,94	61,15	,6196
83	,93080	—	69,31	164,33	4,98	60,85	,6166
84	,93138	—	70,14	165,13	5,01	60,56	,6136
100 + 85	,93194	—	70,98	165,92	5,06	60,27	,6106
86	,93249	—	71,81	166,72	5,09	59,98	,6077
87	,93303	—	72,65	167,52	5,13	59,70	,6048
88	,93357	—	73,48	168,32	5,16	59,41	,6019
89	,93410	—	74,32	169,12	5,20	59,13	,5991
100 + 90	,93461	—	75,15	169,92	5,23	58,85	,5962
91	,93513	—	75,98	170,72	5,26	58,57	,5934
92	,93563	—	76,82	171,52	5,30	58,30	,5906
93	,93613	—	77,65	172,33	5,32	58,03	,5879
94	,93663	—	78,49	173,13	5,36	57,76	,5852
100 + 95	,93712	—	79,33	173,93	5,40	57,49	,5825
96	,93760	—	80,15	174,72	5,43	57,24	,5799
97	,93807	—	80,98	175,52	5,46	56,97	,5772
98	,93854	—	81,82	176,32	5,50	56,71	,5746
99	,93900	—	82,66	177,12	5,54	56,46	,5719

TABLE II. HEAT 37°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100+100	,93947	100	83,51	177,93	5,58	56,19	,5694	100 + 50	,96522	100	167,00	259,79	7,21	38,49	,3900
99	,93991	—	84,36	178,75	5,61	55,94	,5667	49	,96575	—	170,41	263,17	7,24	38,00	,3850
98	,94037	—	85,22	179,59	5,63	55,68	,5641	48	,96628	—	173,96	266,69	7,27	37,49	,3799
97	,94082	—	86,10	180,44	5,66	55,42	,5615	47	,96682	—	177,66	270,38	7,28	36,98	,3748
96	,94127	—	86,99	181,30	5,69	55,16	,5588	46	,96734	—	181,53	274,23	7,30	36,46	,3695
100 + 95	,94172	—	87,90	182,18	5,72	54,88	,5561	100 + 45	,96787	—	185,56	278,26	7,30	35,93	,3641
94	,94219	—	88,83	183,08	5,75	54,62	,5534	44	,96838	—	189,77	282,46	7,31	35,40	,3587
93	,94266	—	89,79	184,00	5,79	54,35	,5506	43	,96889	—	194,19	286,89	7,30	34,85	,3532
92	,94313	—	90,77	184,95	5,82	54,06	,5478	42	,96940	—	198,82	291,51	7,31	34,30	,3476
91	,94361	—	91,76	185,91	5,85	53,79	,5450	41	,96989	—	203,66	296,35	7,31	33,74	,3419
100 + 90	,94408	—	92,79	186,90	5,89	53,51	,5421	100 + 40	,97039	—	208,76	301,46	7,30	33,17	,3361
89	,94459	—	93,82	187,91	5,91	53,22	,5392	39	,97087	—	214,11	306,82	7,29	32,59	,3302
88	,94508	—	94,88	188,94	5,94	52,93	,5363	38	,97136	—	219,74	312,49	7,25	32,00	,3242
87	,94558	—	95,98	190,00	5,98	52,64	,5333	37	,97183	—	225,68	318,46	7,22	31,40	,3181
86	,94608	—	97,10	191,08	6,02	52,34	,5303	36	,97232	—	231,95	324,75	7,20	30,79	,3120
100 + 85	,94658	—	98,24	192,18	6,06	52,04	,5272	100 + 35	,97280	—	238,58	331,40	7,18	30,17	,3057
84	,94710	—	99,40	193,31	6,09	51,73	,5241	34	,97328	—	245,59	338,45	7,14	29,55	,2994
83	,94761	—	100,61	194,47	6,14	51,42	,5210	33	,97376	—	253,04	345,93	7,11	28,91	,2929
82	,94812	—	101,84	195,66	6,18	51,10	,5178	32	,97424	—	260,94	353,90	7,04	28,26	,2863
81	,94863	—	103,09	196,88	6,21	50,79	,5146	31	,97473	—	269,37	362,36	7,01	27,60	,2796
100 + 80	,94913	—	104,38	198,14	6,24	50,47	,5113	100 + 30	,97523	—	278,34	371,38	6,96	26,93	,2728
79	,94965	—	105,70	199,42	6,28	50,14	,5080	29	,97571	—	287,94	381,04	6,90	26,24	,2659
78	,95016	—	107,06	200,74	6,32	49,81	,5047	28	,97622	—	298,22	391,40	6,82	25,55	,2589
77	,95068	—	108,45	202,09	6,36	49,48	,5013	27	,97672	—	309,27	402,51	6,76	24,84	,2517
76	,95120	—	109,87	203,49	6,38	49,14	,4979	26	,97723	—	321,16	414,49	6,67	24,12	,2444
100 + 75	,95171	—	111,33	204,91	6,42	48,80	,4944	100 + 25	,97776	—	334,01	427,41	6,60	23,40	,2370
74	,95224	—	112,83	206,38	6,45	48,45	,4909	24	,97829	—	347,93	441,41	6,52	22,65	,2295
73	,95275	—	114,38	207,89	6,49	48,10	,4873	23	,97884	—	363,06	456,63	6,43	21,90	,2219
72	,95328	—	115,97	209,45	6,52	47,74	,4837	22	,97941	—	379,55	473,24	6,31	21,13	,2141
71	,95380	—	117,60	211,06	6,54	47,39	,4801	21	,97999	—	397,64	491,41	6,23	20,35	,2062
100 + 70	,95433	—	119,29	212,69	6,60	47,01	,4763	100 + 20	,98060	—	417,52	511,41	6,11	19,55	,1981
69	,95486	—	121,01	214,39	6,62	46,65	,4726	19	,98120	—	439,49	533,51	5,98	18,74	,1899
68	,95541	—	122,79	216,13	6,66	46,26	,4688	18	,98182	—	463,90	558,06	5,84	17,92	,1816
67	,95595	—	124,63	217,93	6,70	45,88	,4649	17	,98248	—	491,20	585,49	5,71	17,08	,1731
66	,95649	—	126,52	219,78	6,74	45,50	,4610	16	,98316	—	521,90	616,34	5,56	16,22	,1644
100 + 65	,95704	—	128,47	221,69	6,78	45,11	,4570	100 + 15	,98388	—	556,69	651,29	5,40	15,35	,1556
64	,95759	—	130,47	223,66	6,81	44,71	,4530	14	,98462	—	596,46	691,22	5,24	14,46	,1466
63	,95814	—	132,53	225,69	6,84	44,30	,4489	13	,98540	—	642,34	737,27	5,07	13,56	,1374
62	,95870	—	134,68	227,79	6,89	43,90	,4447	12	,98622	—	695,86	790,98	4,88	12,64	,1281
61	,95925	—	136,88	229,97	6,91	43,48	,4405	11	,98709	—	759,13	854,43	4,70	11,70	,1186
100 + 60	,95980	—	139,16	232,22	6,94	43,06	,4363	100 + 10	,98801	—	835,04	930,55	4,49	10,74	,1089
59	,96035	—	141,52	234,54	6,98	42,63	,4319	9	,98896	—	927,82	1023,55	4,27	9,77	,0990
58	,96090	—	143,96	236,94	7,02	42,20	,4275	8	,98998	—	1043,79	1139,77	4,02	8,78	,0889
57	,96144	—	146,49	239,45	7,04	41,76	,4231	7	,99107	—	1192,91	1289,11	3,80	7,76	,0786
56	,96199	—	149,11	242,04	7,07	41,31	,4186	6	,99223	—	1391,74	1488,17	3,57	6,72	,0681
100 + 55	,96252	—	151,81	244,71	7,10	40,86	,4140	100 + 5	,99344	—	1670,09	1766,78	3,31	5,66	,0573
54	,96307	—	154,60	247,49	7,11	40,40	,4093	4	,99475	—	2087,59	2184,58	3,01	4,58	,0464
53	,96361	—	157,51	250,39	7,12	39,93	,4046	3	,99615	—	2783,45	2880,72	2,73	3,47	,0352
52	,96415	—	160,55	253,40	7,15	39,46	,3998	2	,99765	—	4175,18	4272,71	2,47	2,34	,0237
51	,96467	—	163,72	256,52	7,20	38,98	,3949	1	,99924	—	8350,36	8448,20	2,16	1,18	,0120

TABLE I. HEAT 38°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Spirit and water by weight.	II. Specific gravity.	III Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.								Sp. + W.							
100 + 0	,83536	100	—	100,00	—	100,00	1,0126	100 + 50	,90682	100	41,73	138,18	3,55	72,37	,7328
1	,83766	—	0,83	100,72	0,11	99,28	1,0054	51	,90771	—	42,56	138,96	3,60	71,96	7287
2	,83990	—	1,67	101,45	0,22	98,57	,9982	52	,90858	—	43·39	139,75	3,64	71,56	,7246
3	,84209	—	2,51	102,18	0,33	97,87	,9911	53	,90944	—	44,23	140,54	3,69	71,16	,7205
4	,84424	—	3,34	102,91	0,43	97,18	,9840	54	,91029	—	45·07	141,32	3,75	70,76	,7165
100 + 5	,84631	—	4,18	103,64	0,54	96,49	,9770	100 + 55	,91112	—	45·91	142,11	3,80	70,37	,7125
6	,84834	—	5,01	104,38	0,63	95,80	,9701	56	91194	—	46 73	142,90	3,83	69.98	,7086
7	,85032	—	5,85	105,12	0,73	95,13	,9633	57	,91277	—	47·57	143,69	3,88	69.60	,7047
8	,85224	—	6,68	105,86	0,82	94,46	,9565	58	,91357	—	48,40	144·47	3 93	69,22	,7009
9	,85413	—	7,51	106,61	0,90	93,80	,9498	59	,91435	—	49,24	145,26	3,98	68,84	,6971
100 + 10	,85594	—	8,35	107,36	0,99	93,15	,9432	100 + 60	,91513	—	50,07	146, 5	4,02	68,47	,6933
11	,85774	—	9,18	108,10	1,08	92,50	,9367	61	,91590	—	50,90	146,84	4,06	68,10	,6896
12	,85949	—	10,01	108,86	1,15	91,86	,9302	62	,91664	—	51·74	147,63	4,11	67,74	,6859
13	,86121	—	10,85	109,60	1,25	91,23	,9238	63	,91739	—	52,58	148,42	4,16	67,38	,6822
14	,86288	—	11,68	110,36	1,32	90,61	,9175	64	,91811	—	53,41	149,21	4,20	67,02	6786
100 + 15	,86451	—	12,52	111,12	1,40	89,99	,9112	100 + 65	,91883	—	54,25	150,00	4,25	66,66	6750
16	,86611	—	13,36	111,88	1,48	89,38	,9051	66	,91955	—	55 08	150,79	4,29	66,31	,6715
17	,86769	—	14,19	112,64	1,55	88,78	,8990	67	,92027	—	55,92	151,59	4,33	65,97	,6680
18	,86924	—	15,02	113,40	1,62	88,18	,8930	68	,92096	—	56,75	152,38	4·37	65,62	,6645
19	,87075	—	15,85	114,16	1,69	87,59	,8870	69	,92164	—	57,58	153,17	4,41	65,28	,6611
100 + 20	,87224	—	16,69	114,93	1,76	87,01	,8810	100 + 70	,92233	—	58,42	153,97	4,45	64,95	,6576
21	,87369	—	17,52	115,69	1,83	86,43	,8752	71	,92300	—	59,25	154,77	4·48	64,62	,6543
22	,87512	—	18,36	116,45	1,91	85,86	,8694	72	,92365	—	60,08	155·56	4,52	64,29	,6509
23	,87653	—	19,20	117,22	1,98	85,31	,8638	73	,92430	—	60,92	156 35	4,57	63,96	,6476
24	,87791	—	20,03	117,99	2,04	84,75	,8582	74	,92495	—	61,75	157 15	4,60	63,64	,6443
100 + 25	,87926	—	20,86	118,76	2,10	84,20	,8526	100 + 75	,92558	—	62,59	157·94	4,65	63,32	,6411
26	,88059	—	21,69	119,53	2,16	83,66	,8472	76	,92620	—	63,43	158 73	4,70	63,00	,6379
27	,88191	—	22,53	120,30	2,23	83,13	,8418	77	,92682	—	64,26	159·53	4,73	62,68	,6346
28	,88319	—	23,37	121,07	2,30	82,60	,8364	78	,92743	—	65,09	160,32	4·77	62,37	,6315
29	,88445	—	24,21	121,84	2,37	82,07	,8311	79	,92802	—	65,93	161,12	4,81	62,07	,6285
100 + 30	,88569	—	25,04	122,62	2,42	81,56	,8258	100 + 80	,92865	—	66,76	161,91	4,85	61,76	,6254
31	,88691	—	25,87	123,39	2,48	81,05	,8206	81	,92924	—	67,59	162,71	4,88	61,46	,6223
32	,88812	—	26,71	124,17	2,54	80,54	,8155	82	,92982	—	68,43	163·51	4,92	61,16	,6193
33	,88931	—	27,55	124,94	2,61	80.04	,8105	83	93039	—	69,27	164 31	4 96	60,86	,6163
34	,89047	—	28,38	125,71	2,67	79·55	,8055	84	,93098	—	70.10	165 11	4 99	60,57	,6133
100 + 35	,89161	—	29,21	126,48	2,73	79,06	,8006	100 + 85	,93154	—	70 94	165,90	5·04	60,28	,6103
36	,89274	—	30,05	127,26	2,79	78,58	,7957	86	,93209	—	71,77	166,70	5,07	59,99	,6075
37	,89385	—	30,88	128,03	2,85	78,10	,7909	87	,93263	—	72,61	167·50	5,11	59,70	,6046
38	,89494	—	31,72	128,81	2,91	77,63	,7861	88	,93317	—	73.44	168 30	5 14	59,42	,6017
39	,89600	—	32,54	129,59	2,95	77,16	,7813	89	93370	—	74,28	169,10	5,18	59,14	,5988
100 + 40	,89705	—	33,39	130,37	3,02	76,70	,7767	100 + 90	,93421	—	75,11	169 90	5 21	58,86	,5900
41	,89811	—	34,22	131,15	3,07	76,25	,7721	91	,93473	—	75·94	170,70	5,24	58,58	,5932
42	,89914	—	35,05	131,93	3,12	75,80	,7675	92	,93523	—	76,78	171,50	5,28	58,31	,5904
43	,90015	—	35,89	132,71	3,18	75·35	,7630	93	93573	—	77,61	172,31	5,30	58 04	,5877
44	,90116	—	36,72	133,48	3,24	74,91	,7586	94	,93623	—	78 45	173 11	5 34	57,77	5849
100 + 45	,90215	—	37,55	134,26	3,29	74,48	,7542	100 + 95	,93672	—	79,28	173·91	5,37	57·50	,5823
46	,90310	—	38,39	135,05	3,34	74,05	,7499	96	93720	—	80 10	174,70	5·40	57,24	,5796
47	,90407	—	39,22	135,83	3,39	73,62	,7456	97	,93767	—	80,93	175,50	5 43	56,98	,5770
48	,90500	—	40,06	136,61	3,45	73,20	,7413	98	,93814	—	81,77	176 30	5,47	56.72	,5745
49	,90592	—	40,90	137,39	3,51	72,78	,7370	99	,93860	—	82,61	177,10	5,51	56,46	,5717

TABLE II. HEAT 38°.

I. Water and spirit by weight.	II. Specific gravity.	III Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93907	100	83,46	177,91	5,55	56,20	,5691
99	,93952	—	84,31	178,73	5,58	55,95	,5665
98	,93998	—	85,17	179,56	5,61	55,69	,5639
97	,94043	—	86,05	180,41	5,64	55,42	,5613
96	,94088	—	86,94	181,27	5,67	55,16	,5586
100 + 95	,94134	—	87,85	182,15	5,70	54,89	,5559
94	,94181	—	88,78	183,05	5,73	54,62	,5532
93	,94228	—	89,74	183,97	5,77	54,36	,5504
92	,94275	—	90,71	184,92	5,79	54,08	,5476
91	,94323	—	91,71	185,89	5,82	53,80	,5447
100 + 90	,94370	—	92,73	186,87	5,86	53,51	,5418
89	,94421	—	93,77	187,88	5,89	53,22	,5390
88	,94470	—	94,83	188,91	5,92	52,93	,5361
87	,94520	—	95,93	189,97	5,96	52,64	,5331
86	,94571	—	97,04	191,05	5,99	52,35	,5301
100 + 85	,94621	—	98,19	192,15	6,04	52,04	,5270
84	,94673	—	99,35	193,28	6,07	51,74	,5239
83	,94724	—	100,55	194,44	6,11	51,43	,5208
82	,94775	—	101,78	195,63	6,15	51,11	,5176
81	,94826	—	103,03	196,85	6,18	50,80	,5144
100 + 80	,94876	—	104,32	198,11	6,21	50,48	,5111
79	,94928	—	105,64	199,39	6,25	50,15	,5078
78	,94979	—	107,00	200,71	6,29	49,82	,5045
77	,95031	—	108,39	202,06	6,33	49,49	,5011
76	,95083	—	109,81	203,46	6,35	49,15	,4977
100 + 75	,95134	—	111,27	204,88	6,39	48,81	,4942
74	,95187	—	112,77	206,35	6,42	48,46	,4907
73	,95239	—	114,32	207,86	6,46	48,11	,4871
72	,95292	—	115,91	209,41	6,50	47,75	,4835
71	,95345	—	117,54	211,02	6,52	47,40	,4799
100 + 70	,95398	—	119,22	212,65	6,57	47,02	,4761
69	,95451	—	120,94	214,35	6,59	46,65	,4724
68	,95506	—	122,72	216,09	6,63	46,27	,4686
67	,95560	—	124,56	217,89	6,67	45,89	,4647
66	,95615	—	126,45	219,74	6,71	45,51	,4608
100 + 65	,95670	—	128,40	221,65	6,75	45,12	,4568
64	,95725	—	130,40	223,62	6,78	44,72	,4528
63	,95780	—	132,46	225,65	6,81	44,31	,4487
62	,95836	—	134,60	227,74	6,86	43,91	,4446
61	,95891	—	136,81	229,92	6,89	43,49	,4404
100 + 60	,95947	—	139,08	232,17	6,91	43,07	,4361
59	,96002	—	141,44	234,49	6,95	42,64	,4318
58	,96057	—	143,88	236,89	6,99	42,21	,4274
57	,96112	—	146,41	239,40	7,01	41,77	,4230
56	,96167	—	149,03	241,99	7,04	41,32	,4185
100 + 55	,96221	—	151,73	244,66	7,07	40,87	,4139
54	,96276	—	154,52	247,44	7,08	40,41	,4092
53	,96331	—	157,42	250,33	7,09	39,94	,4045
52	,96385	—	160,46	253,34	7,12	39,47	,3997
51	,96438	—	163,63	256,46	7,17	38,99	,3948

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96493	100	166,91	259,73	7,18	38,50	,3899
49	,96546	—	170,31	263,10	7,21	38,01	,3849
48	,96600	—	173,86	266,62	7,24	37,51	,3798
47	,96654	—	177,56	270,31	7,25	37,00	,3747
46	,96707	—	181,43	274,16	7,27	36,47	,3694
100 + 45	,96760	—	185,46	278,19	7,27	35,94	,3640
44	,96812	—	189,67	282,39	7,28	35,41	,3586
43	,96863	—	194,08	286,81	7,27	34,86	,3531
42	,96915	—	198,71	291,43	7,28	34,31	,3475
41	,96965	—	203,55	296,27	7,28	33,75	,3418
100 + 40	,97015	—	208,64	301,37	7,27	33,18	,3360
39	,97064	—	213,99	306,73	7,26	32,60	,3301
38	,97114	—	219,62	312,39	7,23	32,01	,3242
37	,97162	—	225,55	318,35	7,20	31,41	,3181
36	,97211	—	231,82	324,64	7,18	30,80	,3119
100 + 35	,97260	—	238,45	331,29	7,16	30,18	,3056
34	,97309	—	245,45	338,33	7,12	29,56	,2993
33	,97357	—	252,90	345,81	7,09	28,92	,2928
32	,97406	—	260,80	353,76	7,04	28,27	,2862
31	,97456	—	269,22	362,23	6,99	27,61	,2795
100 + 30	,97506	—	278,19	371,24	6,95	26,94	,2727
29	,97555	—	287,78	380,89	6,89	26,25	,2658
28	,97607	—	298,06	391,25	6,81	25,56	,2588
27	,97658	—	309,10	402,35	6,75	24,85	,2517
26	,97709	—	320,98	414,32	6,66	24,13	,2444
100 + 25	,97763	—	333,82	427,23	6,59	23,41	,2370
24	,97817	—	347,74	441,22	6,52	22,66	,2295
23	,97873	—	362,86	456,43	6,43	21,91	,2219
22	,97931	—	379,34	473,03	6,31	21,14	,2141
21	,97990	—	397,42	491,19	6,23	20,36	,2061
100 + 20	,98052	—	417,29	511,18	6,11	19,56	,1981
19	,98112	—	439,25	533,26	5,99	18,75	,1898
18	,98175	—	463,65	557,80	5,85	17,93	,1815
17	,98242	—	490,93	585,21	5,72	17,09	,1730
16	,98311	—	521,61	616,04	5,57	16,23	,1643
100 + 15	,98383	—	556,38	650,97	5,41	15,36	,1555
14	,98458	—	596,13	690,87	5,26	14,47	,1466
13	,98536	—	641,99	736,89	5,10	13,57	,1374
12	,98619	—	695,48	790,57	4,91	12,65	,1281
11	,98707	—	758,71	853,99	4,72	11,71	,1186
100 + 10	,98799	—	834,58	930,05	4,53	10,75	,1089
9	,98895	—	927,31	1023,01	4,30	9,77	,0990
8	,98997	—	1043,22	1139,16	4,06	8,78	,0889
7	,99107	—	1192,25	1288,41	3,84	7,76	,0786
6	,99223	—	1390,97	1487,36	3,61	6,72	,0681
100 + 5	,99344	—	1669,17	1765,82	3,35	5,66	,0573
4	,99476	—	2086,44	2183,38	3,06	4,58	,0464
3	,99616	—	2781,92	2879,13	2,79	3,47	,0352
2	,99766	—	4172,88	4270,35	2,53	2,34	,0237
1	,99925	—	8345,76	8443,54	2,22	1,18	,0120

TABLE I. HEAT 39°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83491	100	—	100,00	—	100,00	1,0120
1	,83720	—	0,83	100,72	0,11	99,28	1,0048
2	,83944	—	1,67	101,45	0,22	98,57	,9976
3	,84163	—	2,51	102,18	0,33	97,87	,9905
4	,84378	—	3,34	102,91	0,43	97,18	,9834
100 + 5	,84585	—	4,18	103,64	0,54	96,49	,9764
6	,84788	—	5,01	104,38	0,63	95,80	,9696
7	,84987	—	5,84	105,12	0,72	95,13	,9628
8	,85179	—	6,68	105,86	0,82	94,47	,9560
9	,85368	—	7,50	106,60	0,90	93,80	,9493
100 + 10	,85550	—	8,34	107,35	0,99	93,15	,9427
11	,85730	—	9,18	108,10	1,08	92,51	,9362
12	,85905	—	10,01	108,85	1,16	91,87	,9297
13	,86076	—	10,85	109,60	1,25	91,24	,9233
14	,86243	—	11,68	110,36	1,32	90,62	,9170
100 + 15	,86406	—	12,51	111,12	1,39	89,99	,9107
16	,86566	—	13,35	111,88	1,47	89,38	,9046
17	,86724	—	14,18	112,64	1,54	88,78	,8985
18	,86879	—	15,01	113,40	1,61	88,18	,8925
19	,87030	—	15,85	114,16	1,69	87,59	,8865
100 + 20	,87179	—	16,68	114,92	1,76	87,01	,8806
21	,87324	—	17,52	115,69	1,83	86,44	,8748
22	,87468	—	18,35	116,45	1,90	85,87	,8690
23	,87608	—	19,18	117,21	1,97	85,31	,8633
24	,87746	—	20,02	117,98	2,04	84,75	,8577
100 + 25	,87882	—	20,85	118,75	2,10	84,20	,8522
26	,88015	—	21,68	119,52	2,16	83,66	,8468
27	,88147	—	22,52	120,29	2,23	83,13	,8414
28	,88275	—	23,36	121,07	2,29	82,60	,8360
29	,88401	—	24,19	121,84	2,35	82,07	,8307
100 + 30	,88525	—	25,03	122,61	2,41	81,56	,8254
31	,88647	—	25,85	123,39	2,46	81,05	,8202
32	,88768	—	26,69	124,16	2,53	80,54	,8151
33	,88887	—	27,53	124,94	2,59	80,04	,8101
34	,89003	—	28,36	125,71	2,65	79,56	,8051
100 + 35	,89117	—	29,20	126,48	2,72	79,06	,8002
36	,89230	—	30,03	127,26	2,77	78,58	,7953
37	,89341	—	30,87	128,03	2,84	78,10	,7905
38	,89449	—	31,70	128,81	2,89	77,63	,7857
39	,89556	—	32,53	129,59	2,94	77,17	,7809
100 + 40	,89661	—	33,37	130,37	3,00	76,71	,7763
41	,89767	—	34,20	131,14	3,06	76,26	,7717
42	,89870	—	35,03	131,92	3,11	75,81	,7671
43	,89971	—	35,87	132,70	3,17	75,36	,7626
44	,90072	—	36,70	133,48	3,22	74,92	,7582
100 + 45	,90171	—	37,53	134,26	3,27	74,48	,7538
46	,90267	—	38,37	135,04	3,33	74,05	,7495
47	,90363	—	39,20	135,82	3,38	73,63	,7452
48	,90457	—	40,04	136,60	3,44	73,21	,7409
49	,90549	—	40,87	137,39	3,48	72,79	,7366

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90639	100	41,70	138,17	3,53	72,37	,7324
51	,90728	—	42,54	138,95	3,59	71,96	,7283
52	,90815	—	43,37	139,74	3,63	71,56	,7242
53	,90901	—	44,20	140,53	3,67	71,16	,7201
54	,90986	—	45,04	141,31	3,73	70,76	,7162
100 + 55	,91069	—	45,88	142,10	3,78	70,37	,7122
56	,91151	—	46,70	142,89	3,81	69,98	,7083
57	,91234	—	47,54	143,68	3,86	69,60	,7044
58	,91314	—	48,37	144,46	3,91	69,23	,7006
59	,91393	—	49,21	145,25	3,96	68,85	,6968
100 + 60	,91470	—	50,04	146,04	4,00	68,48	,6929
61	,91547	—	50,87	146,83	4,04	68,10	,6893
62	,91622	—	51,71	147,62	4,09	67,74	,6856
63	,91697	—	52,55	148,41	4,14	67,38	,6819
64	,91769	—	53,38	149,20	4,18	67,02	,6783
100 + 65	,91841	—	54,22	149,99	4,23	66,67	,6747
66	,91913	—	55,05	150,78	4,27	66,32	,6712
67	,91985	—	55,89	151,58	4,31	65,97	,6677
68	,92055	—	56,72	152,37	4,35	65,62	,6642
69	,92123	—	57,55	153,16	4,39	65,28	,6608
100 + 70	,92192	—	58,39	153,96	4,43	64,95	,6573
71	,92259	—	59,22	154,75	4,47	64,62	,6540
72	,92325	—	60,05	155,54	4,51	64,29	,6506
73	,92390	—	60,89	156,34	4,55	63,96	,6473
74	,92454	—	61,72	157,13	4,59	63,64	,6440
100 + 75	,92517	—	62,55	157,92	4,63	63,32	,6408
76	,92579	—	63,39	158,71	4,68	63,00	,6376
77	,92641	—	64,23	159,52	4,71	62,68	,6343
78	,92702	—	65,06	160,30	4,76	62,37	,6312
79	,92760	—	65,89	161,10	4,79	62,08	,6282
100 + 80	,92824	—	66,72	161,89	4,83	61,77	,6251
81	,92883	—	67,55	162,69	4,86	61,46	,6220
82	,92941	—	68,39	163,49	4,90	61,16	,6190
83	,92979	—	69,23	164,29	4,94	60,86	,6160
84	,93057	—	70,06	165,09	4,97	60,57	,6130
100 + 85	,93113	—	70,90	165,88	5,02	60,28	,6101
86	,93169	—	71,73	166,68	5,05	59,99	,6072
87	,93223	—	72,57	167,48	5,09	59,71	,6043
88	,93277	—	73,40	168,28	5,12	59,42	,6014
89	,93230	—	74,24	169,08	5,16	59,14	,5985
100 + 90	,93381	—	75,07	169,88	5,19	58,86	,5957
91	,93433	—	75,90	170,68	5,22	58,59	,5929
92	,93483	—	76,74	171,48	5,26	58,31	,5901
93	,93533	—	77,57	172,29	5,28	58,04	,5874
94	,93583	—	78,41	173,09	5,32	57,77	,5847
100 + 95	,93632	—	79,24	173,89	5,35	57,51	,5820
96	,93680	—	80,06	174,68	5,38	57,25	,5794
97	,93727	—	80,89	175,48	5,41	56,99	,5768
98	,93774	—	81,73	176,28	5,45	56,72	,5742
99	,93821	—	82,57	177,08	5,49	56,47	,5717

TABLE II. HEAT 39°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93867	100	83,42	177,89	5,53	56,21	,5689
99	,93913	—	84,27	178,71	5,56	55,95	,5662
98	,93959	—	85,13	179,54	5,59	55,69	,5636
97	,94005	—	86,00	180,39	5,61	55,43	,5610
96	,94050	—	86,89	181,25	5,64	55,17	,5583
100 + 95	,94096	—	87,80	182,12	5,68	54,90	,5557
94	,94143	—	88,73	183,02	5,71	54,63	,5530
93	,94190	—	89,69	183,95	5,74	54,36	,5502
92	,94237	—	90,66	184,90	5,76	54,08	,5474
91	,94285	—	91,66	185,86	5,80	53,80	,5445
100 + 90	,94332	—	92,68	186,84	5,84	53,52	,5416
89	,94383	—	93,72	187,85	5,87	53,23	,5388
88	,94433	—	94,78	188,88	5,90	52,94	,5359
87	,94483	—	95,87	189,94	5,93	52,65	,5329
86	,94534	—	96,99	191,02	5,97	52,36	,5299
100 + 85	,94584	—	98,13	192,12	6,01	52,05	,5268
84	,94636	—	99,29	193,25	6,04	51,75	,5237
83	,94687	—	100,50	194,41	6,09	51,44	,5206
82	,94738	—	101,72	195,60	6,12	51,12	,5174
81	,94789	—	102,97	196,82	6,15	50,80	,5142
100 + 80	,94839	—	104,27	198,08	6,19	50,49	,5109
79	,94891	—	105,58	199,36	6,22	50,16	,5076
78	,94942	—	106,94	200,68	6,26	49,83	,5043
77	,94994	—	108,33	202,03	6,30	49,50	,5009
76	,95046	—	109,75	203,43	6,32	49,15	,4975
100 + 75	,95097	—	111,21	204,85	6,36	48,81	,4940
74	,95150	—	112,71	206,32	6,39	48,47	,4905
73	,95203	—	114,26	207,82	6,44	48,12	,4869
72	,95256	—	115,85	209,38	6,47	47,76	,4833
71	,95310	—	117,48	210,98	6,50	47,40	,4797
100 + 70	,95363	—	119,15	212,61	6,54	47,03	,4760
69	,95417	—	120,87	214,31	6,56	46,66	,4722
68	,95472	—	122,65	216,05	6,60	46,28	,4684
67	,95526	—	124,49	217,85	6,64	45,90	,4646
66	,95581	—	126,38	219,70	6,68	45,52	,4607
100 + 65	,95636	—	128,33	221,61	6,72	45,13	,4567
64	,95691	—	130,33	223,58	6,75	44,73	,4527
63	,95746	—	132,39	225,60	6,79	44,32	,4486
62	,95802	—	134,52	227,70	6,82	43,91	,4445
61	,95857	—	136,73	229,88	6,85	43,50	,4403
100 + 60	,95913	—	139,00	232,12	6,88	43,08	,4360
59	,95969	—	141,36	234,44	6,92	42,65	,4317
58	,96024	—	143,80	236,84	6,96	42,22	,4273
57	,96080	—	146,33	239,35	6,98	41,78	,4229
56	,96135	—	148,95	241,94	7,01	41,33	,4184
100 + 55	,96190	—	151,65	244,61	7,04	40,88	,4137
54	,96245	—	154,44	247,38	7,06	40,42	,4091
53	,96301	—	157,34	250,27	7,07	39,95	,4044
52	,96355	—	160,37	253,28	7,09	39,48	,3996
51	,96409	—	163,54	256,40	7,14	39,00	,3947

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96465	100	166,82	259,67	7,15	38,51	,3897
49	,96517	—	170,22	263,03	7,19	38,02	,3848
48	,96572	—	173,77	266,55	7,22	37,51	,3797
47	,96626	—	177,46	270,24	7,22	37,01	,3746
46	,96680	—	181,33	274,09	7,24	36,48	,3693
100 + 45	,96733	—	185,36	278,12	7,24	35,95	,3639
44	,96786	—	189,57	282,32	7,25	35,42	,3585
43	,96838	—	193,98	286,73	7,25	34,87	,3530
42	,96890	—	198,60	291,34	7,26	34,32	,3474
41	,96941	—	203,44	296,19	7,25	33,76	,3417
100 + 40	,96991	—	208,53	301,28	7,25	33,19	,3359
39	,97041	—	213,87	306,64	7,23	32,61	,3300
38	,97092	—	219,50	312,29	7,21	32,02	,3241
37	,97141	—	225,43	318,25	7,18	31,42	,3180
36	,97191	—	231,69	324,53	7,16	30,81	,3119
100 + 35	,97240	—	238,32	331,18	7,14	30,19	,3056
34	,97290	—	245,32	338,21	7,11	29,57	,2993
33	,97339	—	252,76	345,69	7,07	28,93	,2928
32	,97388	—	260,66	353,63	7,03	28,28	,2862
31	,97439	—	269,07	362,09	6,98	27,62	,2795
100 + 30	,97489	—	278,04	371,10	6,94	26,95	,2727
29	,97539	—	287,62	380,75	6,87	26,26	,2658
28	,97592	—	297,90	391,09	6,81	25,57	,2588
27	,97644	—	308,93	402,19	6,74	24,86	,2517
26	,97696	—	320,81	414,15	6,66	24,14	,2443
100 + 25	,97750	—	333,64	427,05	6,59	23,41	,2370
24	,97805	—	347,55	441,04	6,51	22,67	,2295
23	,97862	—	362,66	456,24	6,42	21,92	,2218
22	,97921	—	379,14	472,82	6,32	21,15	,2140
21	,97981	—	397,20	490,97	6,23	20,37	,2061
100 + 20	,98043	—	417,06	510,95	6,11	19,57	,1981
19	,98104	—	439,01	533,01	6,00	18,76	,1898
18	,98168	—	463,40	557,54	5,86	17,94	,1815
17	,98236	—	490,66	584,93	5,73	17,10	,1730
16	,98306	—	521,32	615,74	5,58	16,24	,1643
100 + 15	,98378	—	556,08	650,65	5,43	15,37	,1555
14	,98454	—	595,80	690,53	5,27	14,48	,1466
13	,98533	—	641,64	736,51	5,13	13,58	,1374
12	,98616	—	695,10	790,17	4,93	12,65	,1281
11	,98705	—	758,29	853,55	4,74	11,71	,1186
100 + 10	,98797	—	834,12	929,56	4,56	10,76	,1089
9	,98894	—	926,80	1022,47	4,33	9,78	,0990
8	,98996	—	1042,65	1138,55	4,10	8,78	,0889
7	,99106	—	1191,60	1287,72	3,88	7,77	,0786
6	,99223	—	1390,20	1486,55	3,65	6,73	,0681
100 + 5	,99344	—	1668,25	1764,86	3,39	5,67	,0573
4	,99476	—	2085,30	2182,19	3,11	4,58	,0464
3	,99616	—	2780,39	2877,55	2,84	3,47	,0352
2	,99766	—	4170,59	4268,01	2,58	2,34	,0237
1	,99925	—	8341,18	8438,90	2,28	1,18	,0120

TABLE I. HEAT 40°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83445	100	—	100,00	—	100,00	1,0114
1	,83674	—	0,83	100,72	0,11	99,28	1,0042
2	,83898	—	1,67	101,45	0,22	98,57	,9970
3	,84117	—	2,50	102,18	0,32	97,87	,9899
4	,84331	—	3,33	102,91	0,42	97,18	,9829
100 + 5	,84539	—	4,17	103,64	0,53	96,49	,9759
6	,84742	—	5,00	104,38	0,62	95,81	,9690
7	,84941	—	5,84	105,12	0,72	95,13	,9622
8	,85134	—	6,67	105,86	0,81	94,47	,9555
9	,85323	—	7,50	106,60	0,90	93,81	,9488
100 + 10	,85507	—	8,34	107,35	0,99	93,16	,9422
11	,85686	—	9,17	108,10	1,07	92,51	,9357
12	,85860	—	10,00	108,85	1,15	91,87	,9292
13	,86031	—	10,84	109,60	1,24	91,24	,9228
14	,86198	—	11,67	110,36	1,31	90,62	,9165
100 + 15	,86361	—	12,50	111,12	1,38	90,00	,9103
16	,86521	—	13,34	111,87	1,47	89,38	,9041
17	,86679	—	14,17	112,63	1,54	88,78	,8980
18	,86834	—	15,01	113,39	1,62	88,19	,8920
19	,86985	—	15,84	114,15	1,69	87,60	,8860
100 + 20	,87134	—	16,67	114,92	1,75	87,02	,8801
21	,87280	—	17,51	115,68	1,83	86,44	,8743
22	,87423	—	18,34	116,45	1,89	85,87	,8686
23	,87564	—	19,17	117,21	1,96	85,31	,8629
24	,87702	—	20,01	117,98	2,03	84,76	,8573
100 + 25	,87838	—	20,84	118,75	2,09	84,21	,8518
26	,87971	—	21,67	119,52	2,15	83,67	,8463
27	,88102	—	22,51	120,29	2,22	83,14	,8409
28	,88231	—	23,34	121,06	2,28	82,61	,8355
29	,88357	—	24,18	121,83	2,35	82,08	,8302
100 + 30	,88481	—	25,01	122,61	2,40	81,57	,8250
31	,88603	—	25,84	123,38	2,46	81,06	,8198
32	,88723	—	26,68	124,16	2,52	80,55	,8147
33	,88842	—	27,51	124,93	2,58	80,05	,8097
34	,88959	—	28,35	125,70	2,65	79,56	,8047
100 + 35	,89073	—	29,18	126,47	2,71	79,07	,7998
36	,89185	—	30,01	127,25	2,76	78,59	,7949
37	,89296	—	30,85	128,02	2,83	78,11	,7901
38	,89404	—	31,68	128,80	2,88	77,64	,7853
39	,89511	—	32,51	129,58	2,93	77,17	,7806
100 + 40	,89617	—	33,35	130,36	2,99	76,71	,7759
41	,89722	—	34,18	131,13	3,05	76,26	,7713
42	,89825	—	35,01	131,91	3,10	75,81	,7667
43	,89927	—	35,85	132,69	3,16	75,36	,7622
44	,90028	—	36,68	133,47	3,21	74,92	,7578
100 + 45	,90127	—	37,51	134,25	3,26	74,49	,7534
46	,90224	—	38,35	135,03	3,32	74,06	,7491
47	,90319	—	39,18	135,81	3,37	73,63	,7448
48	,90413	—	40,02	136,59	3,43	73,21	,7405
49	,90505	—	40,85	137,38	3,47	72,79	,7363

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of Bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90596	100	41,68	138,16	3,52	72,38	,7321
51	,90685	—	42,52	138,95	3,57	71,97	,7280
52	,90772	—	43,35	139,73	3,62	71,57	,7239
53	,90858	—	44,18	140,52	3,66	71,17	,7198
54	,90943	—	45,02	141,30	3,72	70,77	,7158
100 + 55	,91026	—	45,85	142,09	3,76	70,38	,7118
56	,91109	—	46,68	142,88	3,80	69,99	,7079
57	,91191	—	47,52	143,67	3,85	69,61	,7040
58	,91271	—	48,35	144,45	3,90	69,23	,7002
59	,91350	—	49,19	145,24	3,95	68,85	,6964
100 + 60	,91428	—	50,02	146,03	3,99	68,48	,6926
61	,91504	—	50,85	146,82	4,03	68,11	,6889
62	,91579	—	51,69	147,61	4,08	67,75	,6852
63	,91654	—	52,52	148,40	4,12	67,39	,6816
64	,91727	—	53,35	149,19	4,16	67,03	,6780
100 + 65	,91799	—	54,19	149,98	4,21	66,67	,6744
66	,91871	—	55,02	150,77	4,25	66,32	,6708
67	,91943	—	55,86	151,57	4,29	65,98	,6673
68	,92013	—	56,69	152,36	4,33	65,63	,6639
69	,92082	—	57,52	153,15	4,37	65,29	,6605
100 + 70	,92151	—	58,36	153,94	4,42	64,96	,6570
71	,92218	—	59,19	154,73	4,46	64,63	,6537
72	,92284	—	60,02	155,53	4,49	64,30	,6503
73	,92349	—	60,86	156,32	4,54	63,97	,6470
74	,92413	—	61,69	157,11	4,58	63,65	,6437
100 + 75	,92476	—	62,52	157,91	4,61	63,33	,6405
76	,92538	—	63,36	158,70	4,66	63,01	,6373
77	,92600	—	64,19	159,50	4,69	62,69	,6341
78	,92661	—	65,03	160,29	4,74	62,38	,6310
79	,92722	—	65,86	161,09	4,77	62,08	,6279
100 + 80	,92783	—	66,69	161,88	4,81	61,77	,6248
81	,92842	—	67,52	162,68	4,84	61,47	,6217
82	,92900	—	68,36	163,48	4,88	61,17	,6187
83	,92958	—	69,19	164,27	4,92	60,87	,6157
84	,93016	—	70,03	165,07	4,96	60,58	,6127
100 + 85	,93072	—	70,86	165,86	5,00	60,29	,6098
86	,93128	—	71,69	166,66	5,03	60,00	,6069
87	,93183	—	72,53	167,46	5,07	59,72	,6040
88	,93237	—	73,36	168,26	5,10	59,43	,6011
89	,93290	—	74,20	169,06	5,14	59,15	,5983
100 + 90	,93341	—	75,03	169,86	5,17	58,87	,5955
91	,93393	—	75,86	170,66	5,20	58,60	,5927
92	,93443	—	76,70	171,46	5,24	58,32	,5899
93	,93493	—	77,53	172,27	5,26	58,05	,5872
94	,93543	—	78,37	173,07	5,30	57,78	,5845
100 + 95	,93592	—	79,20	173,87	5,33	57,52	,5818
96	,93640	—	80,02	174,66	5,36	57,26	,5791
97	,93687	—	80,85	175,46	5,39	56,99	,5765
98	,93734	—	81,69	176,26	5,43	56,73	,5739
99	,93781	—	82,52	177,06	5,46	56,48	,5713

TABLE II. **HEAT 40°.**

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93827	100	83,37	177,87	5,50	56,22	,5686
99	,93873	—	84,22	178,69	5,53	55,96	,5660
98	,93919	—	85,08	179,52	5,56	55,70	,5634
97	,93966	—	85,96	180,37	5,59	55,44	,5608
96	,94012	—	86,85	181,23	5,62	55,18	,5581
100 + 95	,94058	—	87,76	182,10	5,66	54,91	,5554
94	,94105	—	88,69	183,00	5,69	54,64	,5527
93	,94152	—	89,64	183,93	5,71	54,37	,5499
92	,94199	—	90,61	184,87	5,74	54,09	,5471
91	,94247	—	91,61	185,83	5,78	53,81	,5443
100 + 90	,94295	—	92,63	186,82	5,81	53,53	,5414
89	,94345	—	93,67	187,82	5,85	53,24	,5385
88	,94395	—	94,73	188,85	5,88	52,95	,5356
87	,94445	—	95,82	189,91	5,91	52,66	,5326
86	,94496	—	96,94	190,99	5,95	52,36	,5296
100 + 85	,94547	—	98,08	192,09	5,99	52,06	,5265
84	,94598	—	99,24	193,22	6,02	51,75	,5235
83	,94649	—	100,44	194,38	6,06	51,44	,5204
82	,94700	—	101,67	195,57	6,10	51,13	,5172
81	,94751	—	102,92	196,79	6,13	50,81	,5140
100 + 80	,94802	—	104,21	198,05	6,16	50,49	,5107
79	,94853	—	105,53	199,33	6,20	50,17	,5074
78	,94904	—	106,88	200,65	6,23	49,84	,5041
77	,94956	—	108,27	202,00	6,27	49,50	,5007
76	,95008	—	109,69	203,39	6,30	49,16	,4973
100 + 75	,95060	—	111,15	204,82	6,33	48,82	,4938
74	,95113	—	112,65	206,28	6,37	48,48	,4903
73	,95166	—	114,20	207,79	6,41	48,12	,4867
72	,95220	—	115,79	209,34	6,45	47,77	,4831
71	,95274	—	117,42	210,94	6,48	47,41	,4795
100 + 70	,95328	—	119,09	212,58	6,51	47,04	,4758
69	,95382	—	120,81	214,27	6,54	46,67	,4720
68	,95437	—	122,59	216,01	6,58	46,29	,4682
67	,95492	—	124,42	217,81	6,61	45,91	,4644
66	,95547	—	126,31	219,66	6,65	45,53	,4605
100 + 65	,95602	—	128,26	221,57	6,69	45,14	,4565
64	,95657	—	130,26	223,53	6,73	44,74	,4525
63	,95712	—	132,32	225,56	6,76	44,33	,4484
62	,95768	—	134,45	227,66	6,79	43,92	,4443
61	,95823	—	136,66	229,84	6,82	43,51	,4401
100 + 60	,95879	—	138,94	232,08	6,86	43,09	,4358
59	,95935	—	141,29	234,40	6,89	42,66	,4315
58	,95991	—	143,73	236,80	6,93	42,23	,4271
57	,96047	—	146,25	239,30	6,95	41,79	,4227
56	,96103	—	148,87	241,89	6,98	41,34	,4182
100 + 55	,96159	—	151,57	244,56	7,01	40,89	,4136
54	,96214	—	154,36	247,33	7,03	40,43	,4089
53	,96270	—	157,26	250,22	7,04	39,96	,4042
52	,96325	—	160,29	253,22	7,07	39,49	,3994
51	,96379	—	163,45	256,34	7,11	39,01	,3945
100 + 50	,96434	100	166,73	259,59	7,14	38,52	,3896
49	,96489	—	170,13	262,97	7,16	38,03	,3846
48	,96544	—	173,68	266,49	7,19	37,52	,3795
47	,96598	—	177,37	270,17	7,20	37,02	,3744
46	,96652	—	181,23	274,02	7,21	36,49	,3691
100 + 45	,96706	—	185,26	278,04	7,22	35,96	,3638
44	,96759	—	189,47	282,24	7,23	35,43	,3584
43	,96812	—	193,88	286,65	7,23	34,88	,3529
42	,96864	—	198,49	291,26	7,23	34,33	,3473
41	,96916	—	203,33	296,10	7,23	33,77	,3416
100 + 40	,96967	—	208,42	301,19	7,23	33,20	,3358
39	,97018	—	213,76	306,55	7,21	32,62	,3299
38	,97069	—	219,38	312,19	7,19	32,03	,3240
37	,97119	—	225,31	318,14	7,17	31,43	,3179
36	,97170	—	231,57	324,42	7,15	30,82	,3118
100 + 35	,97220	—	238,19	331,06	7,13	30,21	,3055
34	,97270	—	245,19	338,09	7,10	29,58	,2992
33	,97320	—	252,62	345,57	7,05	28,94	,2927
32	,97370	—	260,52	353,50	7,02	28,29	,2861
31	,97421	—	268,92	361,95	6,97	27,63	,2794
100 + 30	,97472	—	277,89	370,97	6,92	26,96	,2726
29	,97523	—	287,47	380,60	6,87	26,27	,2657
28	,97576	—	297,74	390,93	6,81	25,58	,2587
27	,97629	—	308,76	402,03	6,73	24,87	,2516
26	,97682	—	320,64	413,98	6,66	24,15	,2443
100 + 25	,97737	—	333,46	426,88	6,58	23,42	,2369
24	,97793	—	347,36	440,86	6,50	22,68	,2294
23	,97851	—	362,46	456,05	6,41	21,93	,2218
22	,97910	—	378,94	472,62	6,32	21,16	,2140
21	,97971	—	396,98	490,76	6,22	20,37	,2061
100 + 20	,98033	—	416,83	510,72	6,11	19,58	,1980
19	,98096	—	438,77	532,77	6,00	18,77	,1898
18	,98161	—	463,15	557,28	5,87	17,94	,1815
17	,98229	—	490,39	584,65	5,74	17,10	,1730
16	,98300	—	521,04	615,44	5,60	16,25	,1643
100 + 15	,98373	—	555,78	650,33	5,45	15,38	,1555
14	,98449	—	595,47	690,19	5,28	14,49	,1466
13	,98529	—	641,28	736,14	5,14	13,58	,1374
12	,98613	—	694,72	789,77	4,95	12,66	,1281
11	,98702	—	757,87	853,11	4,76	11,72	,1186
100 + 10	,98795	—	833,66	929,07	4,59	10,76	,1089
9	,98892	—	926,29	1021,93	4,36	9,78	,0990
8	,98995	—	1042,08	1137,94	4,14	8,79	,0889
7	,99105	—	1190,95	1287,03	3,92	7,77	,0786
6	,99222	—	1389,44	1485,75	3,69	6,73	,0681
100 + 5	99345	—	1667,33	1763,90	3,43	5,67	,0573
4	,99476	—	2084,16	2181,00	3,16	4,59	,0464
3	,99616	—	2778,87	2875,98	2,89	3,48	,0352
2	,99766	—	4168,31	4265,67	2,64	2,34	,0237
1	,99925	—	8336,63	8434,27	2,36	1,18	,0120

TABLE I. HEAT 41°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83399	100	—	100,00	—	100,00	1,0109
1	,83628	—	0,83	100,72	0,11	99,28	1,0037
2	,83853	—	1,67	101,45	0,22	98,57	,9965
3	,84072	—	2,50	102,18	0,32	97,87	,9894
4	,84286	—	3,33	102,91	0,42	97,18	,9824
100 + 5	,84493	—	4,17	103,64	0,53	96,49	,9754
6	,84697	—	5,00	104,38	0,62	95,81	,9685
7	,84895	—	5,84	105,12	0,72	95,13	,9617
8	,85088	—	6,67	105,86	0,81	94,47	,9550
9	,85277	—	7,50	106,60	0,90	93,81	,9483
100 + 10	,85461	—	8,34	107,35	0,99	93,16	,9417
11	,85640	—	9,17	108,10	1,07	92,51	,9352
12	,85814	—	10,00	108,85	1,15	91,87	,9288
13	,85985	—	10,84	109,60	1,24	91,24	,9224
14	,86152	—	11,67	110,36	1,31	90,62	,9160
100 + 15	,86315	—	12,49	111,12	1,37	90,00	,9098
16	,86476	—	13,33	111,87	1,46	89,38	,9037
17	,86634	—	14,17	112,63	1,54	88,78	,8976
18	,86789	—	15,00	113,39	1,61	88,19	,8916
19	,86940	—	15,83	114,15	1,68	87,60	,8856
100 + 20	,87088	—	16,66	114,92	1,74	87,02	,8797
21	,87235	—	17,50	115,68	1,82	86,44	,8739
22	,87378	—	18,33	116,44	1,89	85,87	,8681
23	,87519	—	19,16	117,21	1,95	85,31	,8625
24	,87657	—	20,00	117,98	2,02	84,76	,8569
100 + 25	,87793	—	20,83	118,74	2,09	84,21	,8513
26	,87926	—	21,66	119,51	2,15	83,67	,8459
27	,88057	—	22,50	120,28	2,22	83,14	,8405
28	,88186	—	23,33	121,06	2,27	82,61	,8351
29	,88312	—	24,17	121,83	2,34	82,08	,8298
100 + 30	,88436	—	25,00	122,60	2,40	81,57	,8246
31	,88558	—	25,83	123,37	2,46	81,06	,8194
32	,88678	—	26,66	124,15	2,51	80,55	,8143
33	,88797	—	27,49	124,92	2,57	80,05	,8093
34	,88914	—	28,33	125,69	2,64	79,56	,8043
100 + 35	,89029	—	29,16	126,46	2,70	79,07	,7993
36	,89141	—	29,99	127,24	2,75	78,59	,7945
37	,89252	—	30,84	128,01	2,83	78,11	,7897
38	,89360	—	31,66	128,79	2,87	77,64	,7849
39	,89467	—	32,49	129,57	2,92	77,17	,7802
100 + 40	,89572	—	33,33	130,35	2,98	76,71	,7756
41	,89678	—	34,16	131,12	3,04	76,26	,7709
42	,89781	—	34,99	131,90	3,09	75,81	,7664
43	,89884	—	35,83	132,68	3,15	75,37	,7619
44	,89985	—	36,66	133,46	3,20	74,93	,7575
100 + 45	,90084	—	37,49	134,24	3,25	74,49	,7531
46	,90181	—	38,32	135,02	3,30	74,06	,7488
47	,90276	—	39,16	135,80	3,36	73,64	,7445
48	,90370	—	39,99	136,58	3,41	73,22	,7402
49	,90462	—	40,83	137,37	3,46	72,80	,7360

I. Spirit and Water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90553	100	41,66	138,15	3,51	72,39	,7317
51	,90642	—	42,50	138,94	3,56	71,97	,7277
52	,90729	—	43,33	139,72	3,61	71,57	,7236
53	,90815	—	44,15	140,50	3,65	71,17	,7195
54	,90900	—	44,99	141,29	3,70	70,78	,7155
100 + 55	,90984	—	45,82	142,07	3,75	70,39	,7115
56	,91066	—	46,65	142,86	3,79	70,00	,7076
57	,91148	—	47,49	143,65	3,84	69,61	,7037
58	,91228	—	48,32	144,43	3,89	69,23	,6999
59	,91307	—	49,16	145,22	3,94	68,86	,6961
100 + 60	,91385	—	49,99	146,01	3,98	68,49	,6923
61	,91461	—	50,82	146,80	4,02	68,12	,6886
62	,91536	—	51,66	147,59	4,07	67,75	,6849
63	,91611	—	52,49	148,38	4,11	67,39	,6813
64	,91684	—	53,32	149,17	4,15	67,03	,6777
100 + 65	,91756	—	54,16	149,96	4,20	66,68	,6741
66	,91828	—	54,99	150,75	4,24	66,33	,6705
67	,91900	—	55,82	151,55	4,27	65,98	,6670
68	,91971	—	56,65	152,34	4,31	65,64	,6636
69	,92040	—	57,49	153,13	4,36	65,29	,6602
100 + 70	,92109	—	58,32	153,92	4,40	64,97	,6567
71	,92176	—	59,15	154,71	4,44	64,64	,6534
72	,92242	—	59,98	155,51	4,47	64,30	,6500
73	,92307	—	60,82	156,30	4,52	63,98	,6467
74	,92371	—	61,65	157,10	4,55	63,65	,6435
100 + 75	,92434	—	62,48	157,89	4,59	63,34	,6402
76	,92496	—	63,32	158,68	4,64	63,01	,6370
77	,92558	—	64,15	159,49	4,66	62,70	,6338
78	,92619	—	64,99	160,27	4,72	62,39	,6307
79	,92680	—	65,82	161,07	4,75	62,09	,6276
100 + 80	,92741	—	66,65	161,86	4,79	61,78	,6245
81	,92800	—	67,48	162,66	4,82	61,47	,6214
82	,92858	—	68,32	163,46	4,86	61,18	,6184
83	,92916	—	69,15	164,25	4,90	60,88	,6154
84	,92974	—	69,99	165,05	4,94	60,58	,6125
100 + 85	,93030	—	70,82	165,84	4,98	60,29	,6095
86	,93086	—	71,65	166,65	5,00	60,00	,6067
87	,93142	—	72,49	167,44	5,05	59,72	,6038
88	,93195	—	73,32	168,24	5,08	59,43	,6009
89	,93248	—	74,16	169,05	5,11	59,16	,5981
100 + 90	,93299	—	74,99	169,85	5,14	58,88	,5952
91	,93351	—	75,82	170,65	5,17	58,60	,5924
92	,93401	—	76,65	171,44	5,21	58,33	,5897
93	,93451	—	77,49	172,25	5,24	58,06	,5869
94	,93501	—	78,32	173,05	5,27	57,79	,5842
100 + 95	,93550	—	79,15	173,85	5,30	57,52	,5815
96	,93598	—	79,97	174,64	5,33	57,26	,5789
97	,93646	—	80,80	175,44	5,36	57,00	,5763
98	,93693	—	81,64	176,24	5,40	56,74	,5737
99	,93740	—	82,47	177,04	5,43	56,48	,5711

TABLE II. HEAT 41°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93786	100	83,32	177,85	5,47	56,22	,5684
99	,93833	—	84,17	178,66	5,51	55,97	,5658
98	,93879	—	85,03	179,49	5,54	55,71	,5631
97	,93926	—	85,91	180,34	5,57	55,45	,5605
96	,93972	—	86,80	181,20	5,60	55,19	,5579
100 + 95	,94019	—	87,71	182,07	5,64	54,92	,5552
94	,94066	—	88,64	182,98	5,66	54,65	,5525
93	,94113	—	89,59	183,90	5,69	54,38	,5497
92	,94160	—	90,56	184,84	5,72	54,10	,5469
91	,94208	—	91,56	185,80	5,76	53,82	,5441
100 + 90	,94256	—	92,58	186,79	5,79	53,53	,5412
89	,94306	—	93,62	187,79	5,83	53,24	,5383
88	,94356	—	94,68	188,82	5,86	52,95	,5354
87	,94406	—	95,76	189,88	5,88	52,67	,5324
86	,94457	—	96,88	190,97	5,91	52,37	,5294
100 + 85	,94508	—	98,02	192,06	5,96	52,06	,5263
84	,94559	—	99,19	193,20	5,99	51,76	,5233
83	,94610	—	100,38	194,36	6,02	51,45	,5202
82	,94661	—	101,61	195,55	6,06	51,14	,5170
81	,94712	—	102,86	196,76	6,10	50,82	,5138
100 + 80	,94762	—	104,15	198,03	6,12	50,50	,5105
79	,94814	—	105,47	199,30	6,17	50,17	,5072
78	,94866	—	106,82	200,62	6,20	49,84	,5039
77	,94918	—	108,21	201,97	6,24	49,51	,5005
76	,94970	—	109,63	203,36	6,27	49,17	,4971
100 + 75	,95023	—	111,09	204,79	6,30	48,83	,4936
74	,95076	—	112,59	206,25	6,34	48,48	,4901
73	,95129	—	114,14	207,75	6,39	48,13	,4865
72	,95183	—	115,72	209,30	6,42	47,78	,4830
71	,95237	—	117,35	210,90	6,45	47,42	,4794
100 + 70	,95291	—	119,02	212,55	6,47	47,05	,4756
69	,95346	—	120,74	214,24	6,50	46,68	,4719
68	,95401	—	122,52	215,97	6,55	46,30	,4681
67	,95456	—	124,35	217,77	6,58	45,92	,4643
66	,95511	—	126,24	219,62	6,62	45,53	,4604
100 + 65	,95567	—	128,18	221,52	6,66	45,14	,4564
64	,95622	—	130,28	223,49	6,69	44,74	,4524
63	,95677	—	132,24	225,52	6,72	44,34	,4483
62	,95733	—	134,37	227,61	6,76	43,93	,4442
61	,95789	—	136,58	229,80	6,78	43,52	,4400
100 + 60	,95845	—	138,86	232,03	6,83	43,10	,4357
59	,95901	—	141,21	234,36	6,85	42,67	,4314
58	,95957	—	143,65	236,75	6,90	42,24	,4270
57	,96014	—	146,17	239,25	6,92	41,80	,4226
56	,96070	—	148,79	241,83	6,96	41,35	,4181
100 + 55	,96125	—	151,48	244,50	6,98	40,90	,4135
54	,96182	—	154,27	247,27	7,00	40,43	,4088
53	,96238	—	157,17	250,17	7,00	39,97	,4041
52	,96293	—	160,20	253,17	7,03	39,50	,3993
51	,96348	—	163,36	256,28	7,08	39,02	,3944

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96404	100	166,64	259,53	7,11	38,53	,3895
49	,96459	—	170,04	262,90	7,14	38,04	,3845
48	,96514	—	173,58	266,42	7,16	37,53	,3794
47	,96569	—	177,27	270,10	7,17	37,02	,3743
46	,96623	—	181,13	273,95	7,18	36,50	,3690
100 + 45	,96678	—	185,16	277,96	7,20	35,97	,3637
44	,96731	—	189,36	282,16	7,20	35,43	,3583
43	,96785	—	193,77	286,58	7,19	34,89	,3528
42	,96838	—	198,38	291,19	7,19	34,34	,3472
41	,96890	—	203,22	296,01	7,21	33,78	,3415
100 + 40	,96941	—	208,30	301,10	7,20	33,21	,3357
39	,96994	—	213,64	306,45	7,19	32,63	,3299
38	,97045	—	219,26	312,09	7,17	32,04	,3239
37	,97096	—	225,19	318,04	7,15	31,44	,3179
36	,97148	—	231,44	324,31	7,13	30,83	,3117
100 + 35	,97198	—	238,06	330,95	7,11	30,22	,3054
34	,97249	—	245,05	337,97	7,08	29,59	,2991
33	,97300	—	252,48	345,45	7,03	28,95	,2927
32	,97351	—	260,38	353,38	7,00	28,30	,2861
31	,97403	—	268,77	361,82	6,95	27,64	,2794
100 + 30	,97455	—	277,74	370,83	6,91	26,97	,2726
29	,97507	—	287,31	380,46	6,85	26,28	,2657
28	,97560	—	297,57	390,78	6,79	25,59	,2587
27	,97614	—	308,59	401,87	6,72	24,88	,2516
26	,97668	—	320,46	413,82	6,64	24,16	,2443
100 + 25	,97722	—	333,28	426,70	6,58	23,43	,2369
24	,97780	—	347,17	440,67	6,50	22,69	,2294
23	,97839	—	362,26	455,85	6,41	21,93	,2218
22	,97898	—	378,73	472,41	6,32	21,16	,2140
21	,97960	—	396,76	490,54	6,22	20,38	,2061
100 + 20	,98023	—	416,60	510,49	6,11	19,59	,1980
19	,98087	—	438,53	532,52	6,01	18,78	,1898
18	,98152	—	462,90	557,02	5,88	17,95	,1815
17	,98221	—	490,12	584,37	5,75	17,11	,1730
16	,98293	—	520,76	615,14	5,62	16,26	,1643
100 + 15	,98366	—	555,48	650,01	5,47	15,39	,1555
14	,98443	—	595,15	689,85	5,30	14,50	,1465
13	,98524	—	640,92	735,78	5,14	13,59	,1374
12	,98608	—	694,34	789,37	4,97	12,67	,1281
11	,98698	—	757,46	852,67	4,79	11,73	,1186
100 + 10	,98790	—	833,21	928,59	4,62	10,77	,1089
9	,98889	—	925,79	1021,40	4,39	9,79	,0990
8	,98993	—	1041,51	1137,34	4,17	8,79	,0889
7	,99103	—	1190,30	1286,34	3,96	7,77	,0786
6	,99221	—	1388,69	1484,95	3,74	6,73	,0681
100 + 5	,99344	—	1686,43	1762,94	3,49	5,67	,0573
4	,99475	—	2083,03	2179,81	3,22	4,59	,0404
3	,99615	—	2777,36	2874,40	2,96	3,48	,0352
2	,99765	—	4166,03	4263,33	2,70	2,35	,0237
1	,99924	—	8332,10	8429,66	2,44	1,19	,0120

TABLE I. HEAT 42°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83353	100	—	100,00	—	100,00	1,0104
1	,83582	—	0,83	100,72	0,11	99,28	1,0032
2	,83807	—	1,67	101,45	0,22	98,57	,9960
3	,84026	—	2,50	102,18	0,32	97,87	,9889
4	,84240	—	3,33	102,91	0,42	97,18	,9819
100 + 5	,84447	—	4,17	103,64	0,53	96,49	,9749
6	,84651	—	5,00	104,38	0,62	95,81	,9680
7	,84849	—	5,83	105,12	0,71	95,13	,9612
8	,85042	—	6,66	105,86	0,80	94,47	,9545
9	,85231	—	7,49	106,60	0,89	93,81	,9478
100 + 10	,85415	—	8,33	107,35	0,98	93,16	,9412
11	,85594	—	9,16	108,10	1,06	92,51	,9347
12	,85768	—	10,00	108,85	1,15	91,87	,9283
13	,85939	—	10,83	109,60	1,23	91,24	,9219
14	,86106	—	11,66	110,36	1,30	90,62	,9156
100 + 15	,86269	—	12,48	111,11	1,37	90,00	,9093
16	,86430	—	13,32	111,87	1,45	89,38	,9032
17	,86588	—	14,16	112,63	1,53	88,78	,8971
18	,86743	—	14,99	113,39	1,60	88,19	,8911
19	,86895	—	15,82	114,15	1,67	87,60	,8851
100 + 20	,87043	—	16,65	114,91	1,74	87,02	,8792
21	,87190	—	17,49	115,68	1,81	86,45	,8734
22	,87333	—	18,32	116,44	1,88	85,88	,8677
23	,87474	—	19,15	117,20	1,95	85,32	,8620
24	,87612	—	19,98	117,97	2,01	84,76	,8564
100 + 25	,87748	—	20,82	118,74	2,08	84,22	,8509
26	,87881	—	21,65	119,51	2,14	83,68	,8454
27	,88012	—	22,49	120,28	2,21	83,14	,8409
28	,88141	—	23,32	121,05	2,27	82,61	,8347
29	,88267	—	24,15	121,82	2,33	82,09	,8294
100 + 30	,88390	—	24,98	122,69	2,39	81,57	,8241
31	,88513	—	25,81	123,37	2,44	81,06	,8190
32	,88633	—	26,65	124,14	2,51	80,56	,8139
33	,88752	—	27,48	124,92	2,56	80,06	,8089
34	,88869	—	28,32	125,68	2,64	79,57	,8039
100 + 35	,88984	—	29,15	126,46	2,69	79,08	,7989
36	,89096	—	29,98	127,23	2,75	78,60	,7941
37	,89207	—	30,82	128,01	2,81	78,12	,7893
38	,89316	—	31,65	128,78	2,87	77,65	,7845
39	,89423	—	32,47	129,56	2,91	77,18	,7798
100 + 40	,89528	—	33,31	130,34	2,97	76,72	,7752
41	,89634	—	34,14	131,11	3,03	76,27	,7706
42	,89738	—	34,97	131,89	3,08	75,82	,7661
43	,89840	—	35,81	132,67	3,14	75,37	,7616
44	,89941	—	36,64	133,45	3,19	74,93	,7571
100 + 45	,90041	—	37,47	134,23	3,24	74,50	,7527
46	,90138	—	38,30	135,01	3,29	74,07	,7484
47	,90232	—	39,14	135,79	3,35	73,64	,7441
48	,90327	—	39,97	136,57	3,40	73,22	,7399
49	,90419	—	40,80	137,35	3,45	72,80	,7356

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90510	100	41,64	138,14	3,50	72,39	,7314
51	,90599	—	42,47	138,93	3,54	71,98	,7273
52	,90686	—	43,30	139,71	3,59	71,58	,7232
53	,90772	—	44,13	140,49	3,64	71,18	,7191
54	,90857	—	44,97	141,28	3,69	70,78	,7151
100 + 55	,90941	—	45,80	142,06	3,74	70,39	,7112
56	,91023	—	46,63	142,85	3,78	70,00	,7073
57	,91105	—	47,46	143,64	3,82	69,62	,7034
58	,91185	—	48,30	144,42	3,88	69,24	,6996
59	,91263	—	49,14	145,21	3,93	68,86	,6958
100 + 60	,91341	—	49,96	146,00	3,96	68,49	,6920
61	,91418	—	50,80	146,79	4,01	68,12	,6883
62	,91493	—	51,63	147,58	4,05	67,76	,6846
63	,91568	—	52,46	148,37	4,09	67,40	,6810
64	,91641	—	53,29	149,16	4,13	67,04	,6773
100 + 65	,91713	—	54,13	149,95	4,18	66,68	,6737
66	,91785	—	54,96	150,74	4,22	66,33	,6702
67	,91857	—	55,79	151,54	4,25	65,99	,6667
68	,91928	—	56,62	152,33	4,29	65,64	,6633
69	,91998	—	57,46	153,12	4,34	65,30	,6598
100 + 70	,92066	—	58,29	153,91	4,38	64,97	,6564
71	,92133	—	59,12	154,70	4,42	64,64	,6531
72	,92200	—	59,95	155,50	4,45	64,31	,6497
73	,92265	—	60,79	156,29	4,50	63,98	,6464
74	,92329	—	61,62	157,08	4,54	63,66	,6432
100 + 75	,92391	—	62,45	157,88	4,57	63,34	,6399
76	,92454	—	63,29	158,67	4,62	63,02	,6367
77	,92516	—	64,12	159,48	4,64	62,71	,6335
78	,92577	—	64,96	160,26	4,70	62,40	,6304
79	,92638	—	65,79	161,05	4,74	62,09	,6273
100 + 80	,92699	—	66,62	161,85	4,77	61,78	,6242
81	,92758	—	67,45	162,65	4,80	61,48	,6211
82	,92816	—	68,28	163,45	4,83	61,18	,6181
83	,92874	—	69,12	164,24	4,88	60,88	,6151
84	,92932	—	69,95	165,04	4,91	60,59	,6122
100 + 85	,92988	—	70,78	165,83	4,95	60,30	,6093
86	,93044	—	71,61	166,63	4,98	60,01	,6064
87	,93101	—	72,45	167,43	5,02	59,73	,6035
88	,93153	—	73,28	168,23	5,05	59,44	,6006
89	,93206	—	74,11	169,03	5,08	59,16	,5978
100 + 90	,93257	—	74,95	169,83	5,12	58,88	,5950
91	,93309	—	75,78	170,63	5,15	58,61	,5922
92	,93359	—	76,61	171,43	5,18	58,33	,5894
93	,93409	—	77,45	172,23	5,22	58,06	,5866
94	,93459	—	78,28	173,03	5,25	57,79	,5840
100 + 95	,93508	—	79,11	173,83	5,28	57,53	,5813
96	,93556	—	79,93	174,62	5,31	57,27	,5786
97	,93604	—	80,76	175,42	5,34	57,01	,5760
98	,93651	—	81,59	176,21	5,38	56,75	,5734
99	,93699	—	82,43	177,02	5,41	56,49	,5708

TABLE II. HEAT 42°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93744	100	83,28	177,83	5,45	56,23	,5681
99	,93792	—	84,13	178,64	5,49	55,97	,5655
98	,93838	—	84,99	179,47	5,52	55,72	,5629
97	,93885	—	85,86	180,32	5,54	55,45	,5603
96	,93932	—	86,75	181,18	5,57	55,19	,5576
100 + 95	,93980	—	87,66	182,05	5,61	54,92	,5549
94	,94026	—	88,59	182,95	5,64	54,66	,5522
93	,94074	—	89,54	183,88	5,66	54,39	,5495
92	,94120	—	90,51	184,82	5,69	54,11	,5467
91	,94168	—	91,51	185,78	5,73	53,82	,5439
100 + 90	,94216	—	92,53	186,77	5,76	53,54	,5410
89	,94266	—	93,57	187,76	5,81	53,25	,5381
88	,94316	—	94,63	188,80	5,83	52,96	,5352
87	,94366	—	95,71	189,86	5,85	52,67	,5322
86	,94417	—	96,83	190,94	5,89	52,37	,5292
100 + 85	,94468	—	97,97	192,04	5,93	52,07	,5261
84	,94519	—	99,13	193,17	5,96	51,77	,5231
83	,94570	—	100,33	194,33	6,00	51,46	,5199
82	,94621	—	101,56	195,52	6,04	51,14	,5168
81	,94672	—	102,81	196,74	6,07	50,83	,5136
100 + 80	,94722	—	104,09	198,00	6,09	50,51	,5103
79	,94775	—	105,41	199,28	6,13	50,18	,5070
78	,94827	—	106,76	200,59	6,17	49,85	,5037
77	,94879	—	108,15	201,94	6,21	49,52	,5003
76	,94932	—	109,57	203,33	6,24	49,18	,4969
100 + 75	,94985	—	111,03	204,76	6,27	48,84	,4934
74	,95038	—	112,53	206,22	6,31	48,49	,4899
73	,95091	—	114,08	207,72	6,36	48,14	,4863
72	,95145	—	115,66	209,27	6,39	47,78	,4828
71	,95200	—	117,28	210,87	6,41	47,42	,4792
100 + 70	,95254	—	118,96	212,51	6,45	47,05	,4754
69	,95309	—	120,67	214,20	6,47	46,68	,4717
68	,95364	—	122,45	215,94	6,51	46,30	,4679
67	,95419	—	124,28	217,73	6,55	45,92	,4641
66	,95475	—	126,17	219,58	6,59	45,54	,4602
100 + 65	,95531	—	128,11	221,48	6,63	45,15	,4562
64	,95586	—	130,21	223,45	6,66	44,75	,4522
63	,95641	—	132,17	225,48	6,69	44,35	,4481
62	,95698	—	134,30	227,57	6,73	43,94	,4440
61	,95754	—	136,51	229,75	6,76	43,52	,4398
100 + 60	,95810	—	138,78	231,99	6,79	43,11	,4355
59	,95866	—	141,14	234,31	6,83	42,68	,4312
58	,95923	—	143,57	236,70	6,87	42,24	,4268
57	,95981	—	146,09	239,20	6,89	41,80	,4224
56	,96036	—	148,71	241,78	6,93	41,36	,4179
100 + 55	,96092	—	151,40	244,45	6,95	40,90	,4133
54	,96149	—	154,19	247,22	6,97	40,44	,4087
53	,96205	—	157,08	250,11	6,97	39,98	,4040
52	,96261	—	160,11	253,11	7,00	39,51	,3992
51	,96317	—	163,27	256,22	7,05	39,03	,3943

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96373	100	166,55	259,47	7,08	38,54	,3894
49	,96428	—	169,95	262,84	7,11	38,05	,3844
48	,96484	—	173,48	266,36	7,12	37,54	,3793
47	,96539	—	177,17	270,03	7,14	37,03	,3742
46	,96594	—	181,03	273,88	7,15	36,51	,3689
100 + 45	,96650	—	185,00	277,89	7,17	35,98	,3636
44	,96703	—	189,26	282,08	7,18	35,44	,3582
43	,96757	—	193,66	286,50	7,16	34,90	,3527
42	,96811	—	198,27	291,11	7,16	34,35	,3471
41	,96864	—	203,11	295,93	7,18	33,79	,3414
100 + 40	,96915	—	208,18	301,01	7,17	33,22	,3356
39	,96969	—	213,52	306,36	7,16	32,64	,3298
38	,97021	—	219,14	311,99	7,15	32,05	,3238
37	,97072	—	225,07	317,94	7,13	31,45	,3178
36	,97125	—	231,31	324,21	7,10	30,84	,3116
100 + 35	,97176	—	237,93	330,84	7,09	30,23	,3054
34	,97228	—	244,92	337,86	7,06	29,60	,2991
33	,97280	—	252,34	345,34	7,00	28,96	,2926
32	,97332	—	260,24	353,26	6,98	28,31	,2860
31	,97384	—	268,62	361,69	6,93	27,65	,2793
100 + 30	,97438	—	277,59	370,69	6,90	26,98	,2725
29	,97490	—	287,15	380,32	6,83	26,29	,2656
28	,97543	—	297,41	390,64	6,77	25,60	,2586
27	,97596	—	308,42	401,72	6,70	24,89	,2515
26	,97653	—	320,29	413,66	6,63	24,17	,2442
100 + 25	,97708	—	333,10	426,53	6,57	23,44	,2369
24	,97766	—	346,98	440,48	6,50	22,70	,2294
23	,97826	—	362,06	455,66	6,40	21,94	,2218
22	,97886	—	378,52	472,20	6,32	21,17	,2140
21	,97948	—	396,54	490,32	6,22	20,39	,2061
100 + 20	,98013	—	416,37	510,26	6,11	19,60	,1980
19	,98077	—	438,29	532,28	6,01	18,79	,1898
18	,98143	—	462,65	556,76	5,89	17,96	,1815
17	,98212	—	489,85	584,09	5,76	17,12	,1730
16	,98285	—	520,48	614,84	5,64	16,26	,1643
100 + 15	,98359	—	555,18	649,69	5,49	15,39	,1555
14	,98436	—	594,83	689,51	5,32	14,50	,1465
13	,98518	—	640,56	735,42	5,14	13,59	,1374
12	,98603	—	693,96	788,97	4,99	12,67	,1281
11	,98693	—	757,05	852,24	4,81	11,73	,1186
100 + 10	,98786	—	832,76	928,11	4,65	10,77	,1089
9	,98885	—	925,29	1020,87	4,42	9,79	,0990
8	,98990	—	1040,95	1136,74	4,21	8,80	,0889
7	,99101	—	1189,66	1285,66	4,00	7,78	,0786
6	,99219	—	1387,94	1484,15	3,79	6,74	,0681
100 + 5	,99343	—	1665,53	1761,95	3,54	5,68	,0573
4	,99474	—	2081,90	2178,62	3,28	4,59	,0464
3	,99614	—	2775,86	2872,83	3,03	3,48	,0352
2	,99764	—	4163,75	4261,01	2,74	2,35	,0237
1	,99923	—	8326,59	8425,08	2,51	1,19	,0120

TABLE I. HEAT 43°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83307	100	—	100,00	—	100,00	1,0098
1	,83536	—	0,83	100,72	0,11	99,28	1,0026
2	,83761	—	1,67	101,45	0,22	98,57	,9955
3	,83980	—	2,50	102,17	0,33	97,87	,9884
4	,84194	—	3,33	102,90	0,43	97,18	,9814
100 + 5	,84401	—	4,17	103,64	0,53	96,49	,9744
6	,84605	—	5,00	104,38	0,62	95,81	,9675
7	,84803	—	5,83	105,12	0,71	95,13	,9607
8	,84996	—	6,66	105,86	0,80	94,47	,9540
9	,85185	—	7,49	106,60	0,89	93,81	,9473
100 + 10	,85369	—	8,32	107,35	0,97	93,16	,9407
11	,85548	—	9,16	108,10	1,06	92,51	,9342
12	,85722	—	9,99	108,85	1,14	91,87	,9278
13	,85893	—	10,82	109,60	1,22	91,24	,9214
14	,86060	—	11,65	110,35	1,30	90,62	,9151
100 + 15	,86223	—	12,48	111,11	1,37	90,00	,9088
16	,86384	—	13,32	111,87	1,45	89,39	,9027
17	,86542	—	14,15	112,63	1,52	88,79	,8966
18	,86697	—	14,98	113,39	1,59	88,19	,8906
19	,86850	—	15,81	114,15	1,66	87,60	,8847
100 + 20	,86997	—	16,65	114,91	1,74	87,02	,8787
21	,87145	—	17,48	115,67	1,81	86,45	,8729
22	,87288	—	18,31	116,43	1,88	85,88	,8672
23	,87429	—	19,14	117,20	1,94	85,32	,8616
24	,87567	—	19,97	117,97	2,00	84,77	,8559
100 + 25	,87703	—	20,80	118,73	2,07	84,22	,8504
26	,87836	—	21,64	119,50	2,14	83,68	,8450
27	,87967	—	22,47	120,27	2,20	83,15	,8396
28	,88096	—	23,30	121,05	2,25	82,62	,8343
29	,88222	—	24,14	121,81	2,33	82,09	,8290
100 + 30	,88345	—	24,97	122,59	2,38	81,58	,8237
31	,88468	—	25,80	123,36	2,44	81,07	,8186
32	,88588	—	26,63	124,14	2,49	80,56	,8135
33	,88707	—	27,46	124,91	2,55	80,06	,8085
34	,88824	—	28,30	125,68	2,62	79,57	,8035
100 + 35	,88939	—	29,13	126,45	2,68	79,08	,7985
36	,89052	—	29,96	127,23	2,73	78,60	,7937
37	,89163	—	30,80	128,00	2,80	78,12	,7889
38	,89271	—	31,63	128,78	2,85	77,65	,7841
39	,89379	—	32,46	129,56	2,90	77,18	,7794
100 + 40	,89484	—	33,30	130,34	2,96	76,72	,7748
41	,89590	—	34,13	131,11	3,02	76,27	,7702
42	,89694	—	34,95	131,89	3,06	75,82	,7657
43	,89796	—	35,79	132,66	3,13	75,38	,7612
44	,89897	—	36,62	133,44	3,18	74,94	,7567
100 + 45	,89997	—	37,45	134,22	3,23	74,50	,7523
46	,90095	—	38,28	135,00	3,28	74,07	,7480
47	,90189	—	39,12	135,78	3,34	73,65	,7437
48	,90284	—	39,95	136,56	3,39	73,23	,7395
49	,90376	—	40,78	137,34	3,44	72,81	,7353
100 + 50	,90467	100	41,61	138,13	3,48	72,40	,7310
51	,90556	—	42,45	138,91	3,54	71,99	,7270
52	,90643	—	43,28	139,70	3,58	71,58	,7229
53	,90729	—	44,10	140,48	3,62	71,18	,7188
54	,90814	—	44,94	141,27	3,67	70,79	,7148
100 + 55	,90898	—	45,78	142,05	3,73	70,40	,7108
56	,90980	—	46,60	142,84	3,76	70,01	,7069
57	,91062	—	47,44	143,63	3,81	69,62	,7030
58	,91141	—	48,27	144,41	3,86	69,24	,6993
59	,91220	—	49,11	145,20	3,91	68,87	,6955
100 + 60	,91297	—	49,93	145,99	3,94	68,50	,6917
61	,91375	—	50,77	146,78	3,99	68,13	,6880
62	,91450	—	51,60	147,57	4,03	67,76	,6843
63	,91525	—	52,43	148,36	4,07	67,40	,6807
64	,91598	—	53,26	149,15	4,11	67,04	,6770
100 + 65	,91670	—	54,10	149,94	4,16	66,69	,6734
66	,91742	—	54,93	150,73	4,20	66,34	,6699
67	,91814	—	55,76	151,52	4,24	65,99	,6664
68	,91885	—	56,59	152,32	4,27	65,65	,6630
69	,91955	—	57,43	153,10	4,33	65,31	,6595
100 + 70	,92023	—	58,26	153,89	4,37	64,98	,6561
71	,92090	—	59,09	154,68	4,41	64,65	,6527
72	,92157	—	59,92	155,48	4,44	64,32	,6494
73	,92222	—	60,75	156,27	4,48	63,99	,6461
74	,92286	—	61,59	157,07	4,52	63,67	,6429
100 + 75	,92348	—	62,42	157,86	4,56	63,35	,6397
76	,92412	—	63,25	158,65	4,60	63,03	,6364
77	,92474	—	64,08	159,46	4,62	62,71	,6332
78	,92535	—	64,92	160,24	4,68	62,40	,6301
79	,92596	—	65,75	161,04	4,71	62,10	,6270
100 + 80	,92656	—	66,58	161,83	4,75	61,79	,6239
81	,92715	—	67,41	162,63	4,78	61,49	,6208
82	,92774	—	68,24	163,43	4,81	61,19	,6178
83	,92831	—	69,08	164,22	4,86	60,89	,6148
84	,92889	—	69,91	165,02	4,89	60,60	,6119
100 + 85	,92945	—	70,74	165,81	4,93	60,31	,6090
86	,93001	—	71,57	166,62	4,95	60,02	,6061
87	,93059	—	72,41	167,41	5,00	59,74	,6032
88	,93110	—	73,24	168,21	5,03	59,45	,6003
89	,93164	—	74,07	169,01	5,06	59,17	,5975
100 + 90	,93215	—	74,91	169,81	5,10	58,89	,5947
91	,93267	—	75,74	170,61	5,13	58,62	,5919
92	,93317	—	76,57	171,41	5,16	58,34	,5891
93	,93367	—	77,41	172,21	5,20	58,07	,5864
94	,93417	—	78,23	173,01	5,22	57,80	,5837
100 + 95	,93466	—	79,06	173,81	5,25	57,54	,5810
96	,93514	—	79,88	174,60	5,28	57,28	,5784
97	,93562	—	80,71	175,40	5,31	57,01	,5758
98	,93610	—	81,55	176,19	5,36	56,75	,5732
99	,93657	—	82,38	177,00	5,38	56,50	,5705

TABLE II.

HEAT 43°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93703	100	83,23	177,81	5,42	56,24	,5679
99	,93751	—	84,09	178,62	5,47	55,98	,5653
98	,93798	—	84,94	179,45	5,49	55,72	,5626
97	,93845	—	85,81	180,29	5,52	55,46	,5600
96	,93892	—	86,70	181,15	5,55	55,20	,5574
100 + 95	,93940	—	87,61	182,02	5,59	54,93	,5547
94	,93987	—	88,54	182,93	5,61	54,66	,5520
93	,94034	—	89,49	183,85	5,64	54,39	,5493
92	,94080	—	90,46	184,79	5,67	54,11	,5465
91	,94128	—	91,46	185,75	5,71	53,83	,5437
100 + 90	,94176	—	92,48	186,74	5,74	53,55	,5407
89	,94226	—	93,52	187,73	5,78	53,26	,5379
88	,94276	—	94,58	188,77	5,81	52,97	,5350
87	,94326	—	95,66	189,83	5,83	52,68	,5320
86	,94377	—	96,77	190,92	5,85	52,38	,5290
100 + 85	,94428	—	97,91	192,01	5,90	52,08	,5259
84	,94479	—	99,08	193,15	5,93	51,78	,5228
83	,94530	—	100,27	194,31	5,96	51,47	,5197
82	,94581	—	101,50	195,50	6,00	51,15	,5166
81	,94632	—	102,75	196,71	6,04	50,83	,5134
100 + 80	,94683	—	104,03	197,97	6,06	50,51	,5101
79	,94736	—	105,35	199,25	6,10	50,19	,5068
78	,94788	—	106,70	200,56	6,14	49,86	,5035
77	,94841	—	108,09	201,91	6,18	49,52	,5001
76	,94894	—	109,51	203,30	6,21	49,18	,4967
100 + 75	,94947	—	110,97	204,72	6,25	48,84	,4932
74	,95000	—	112,47	206,19	6,28	48,50	,4897
73	,95054	—	114,02	207,68	6,34	48,15	,4861
72	,95108	—	115,59	209,24	6,35	47,79	,4826
71	,95163	—	117,22	210,83	6,39	47,43	,4790
100 + 70	,95217	—	118,89	212,48	6,41	47,06	,4752
69	,95272	—	120,61	214,17	6,44	46,69	,4715
68	,95327	—	122,38	215,90	6,48	46,31	,4677
67	,95383	—	124,21	217,69	6,52	45,93	,4639
66	,95439	—	126,10	219,54	6,56	45,55	,4600
100 + 65	,95495	—	128,04	221,44	6,60	45,16	,4560
64	,95550	—	130,14	223,41	6,63	44,76	,4520
63	,95606	—	132,10	225,44	6,66	44,36	,4479
62	,95663	—	134,23	227,53	6,70	43,95	,4438
61	,95719	—	136,44	229,71	6,73	43,53	,4396
100 + 60	,95775	—	138,71	231,95	6,76	43,11	,4353
59	,95831	—	141,06	234,27	6,79	42,68	,4310
58	,95889	—	143,49	236,66	6,83	42,25	,4266
57	,95948	—	146,01	239,15	6,86	41,81	,4222
56	,96002	—	148,63	241,73	6,90	41,36	,4177
100 + 55	,96059	—	151,32	244,40	6,92	40,91	,4132
54	,96116	—	154,11	247,17	6,94	40,45	,4086
53	,96173	—	157,00	250,05	6,95	39,99	,4039
52	,96229	—	160,02	253,05	6,97	39,52	,3991
51	,96286	—	163,18	256,16	7,02	39,04	,3942
100 + 50	,96342	100	166,46	259,41	7,05	38,55	,3893
49	,96398	—	169,86	262,78	7,08	38,06	,3843
48	,96454	—	173,39	266,30	7,09	37,55	,3792
47	,96509	—	177,08	269,97	7,11	37,04	,3741
46	,96565	—	180,93	273,81	7,12	36,52	,3688
100 + 45	,96621	—	184,96	277,82	7,14	35,99	,3635
44	,96675	—	189,16	282,01	7,15	35,45	,3581
43	,96729	—	193,56	286,42	7,14	34,91	,3526
42	,96784	—	198,16	291,03	7,13	34,36	,3470
41	,96838	—	203,00	295,85	7,15	33,80	,3413
100 + 40	,96890	—	208,07	300,92	7,15	33,23	,3356
39	,96944	—	213,40	306,27	7,13	32,65	,3297
38	,96997	—	219,02	311,90	7,12	32,06	,3238
37	,97049	—	224,95	317,84	7,11	31,46	,3177
36	,97102	—	231,19	324,11	7,08	30,85	,3116
100 + 35	,97154	—	237,80	330,73	7,07	30,24	,3053
34	,97207	—	244,79	337,75	7,04	29,61	,2990
33	,97260	—	252,20	345,22	6,98	28,97	,2925
32	,97313	—	260,10	353,14	6,96	28,32	,2860
31	,97366	—	268,48	361,56	6,92	27,66	,2793
100 + 30	,97420	—	277,44	370,55	6,89	26,98	,2725
29	,97473	—	286,99	380,18	6,81	26,30	,2656
28	,97527	—	297,25	390,49	6,76	25,61	,2586
27	,97582	—	308,26	401,57	6,69	24,90	,2515
26	,97638	—	320,12	413,50	6,62	24,18	,2442
100 + 25	,97694	—	332,92	426,35	6,57	23,45	,2368
24	,97753	—	346,79	440,30	6,49	22,71	,2293
23	,97813	—	361,86	455,47	6,39	21,95	,2217
22	,97874	—	378,32	472,00	6,32	21,18	,2139
21	,97937	—	396,33	490,11	6,22	20,40	,2060
100 + 20	,98002	—	416,15	510,03	6,12	19,61	,1980
19	,98067	—	438,05	532,04	6,01	18,80	,1898
18	,98134	—	462,40	556,50	5,90	17,97	,1814
17	,98204	—	489,59	583,82	5,77	17,13	,1729
16	,98277	—	520,20	614,55	5,65	16,27	,1643
100 + 15	,98352	—	554,88	649,38	5,50	15,40	,1555
14	,98430	—	594,51	689,17	5,34	14,51	,1465
13	,98512	—	640,20	735,06	5,14	13,60	,1374
12	,98598	—	693,59	788,57	5,02	12,68	,1280
11	,98688	—	756,64	851,81	4,83	11,74	,1185
100 + 10	,98782	—	832,31	927,03	4,68	10,78	,1089
9	,98882	—	924,79	1020,34	4,45	9,80	,0990
8	,98987	—	1040,39	1136,14	4,25	8,80	,0889
7	,99099	—	1189,02	1284,98	4,04	7,78	,0786
6	,99217	—	1387,19	1483,36	3,83	6.74	,0681
100 + 5	,99342	—	1664,03	1761,04	3,59	5,68	,0573
4	,99473	—	2080,77	2177,44	3,33	4,59	,0464
3	,99613	—	2773,36	2871,27	3,09	3,48	,0352
2	,99763	—	4161,48	4258,69	2,79	2,35	.0237
1	,99922	—	8323,10	8420,51	2,59	1,19	,0120

TABLE I. HEAT 44°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83261	100	—	100,00	—	100,00	1,0092
1	,83490	—	0,83	100,72	0,11	99,28	1,0020
2	,83715	—	1,66	101,44	0,22	98,57	,9949
3	,83934	—	2,50	102,17	0,33	97,87	,9878
4	,84148	—	3,33	102,90	0,43	97,18	,9808
100 + 5	,84355	—	4,17	103,64	0,53	96,49	,9738
6	,84559	—	4,99	104,37	0,62	95,81	,9670
7	,84757	—	5,82	105,11	0,71	95,14	,9602
8	,84950	—	6,66	105,85	0,81	94,47	,9535
9	,85139	—	7,49	106,60	0,89	93,81	,9468
100 + 10	,85323	—	8,32	107,34	0,98	93,16	,9402
11	,85502	—	9,15	108,09	1,06	92,52	,9337
12	,85676	—	9,99	108,84	1,15	91,88	,9273
13	,85847	—	10,82	109,59	1,23	91,25	,9209
14	,86014	—	11,65	110,35	1,30	90,62	,9146
100 + 15	,86177	—	12,47	111,11	1,36	90,00	,9083
16	,86338	—	13,31	111,86	1,45	89,39	,9022
17	,86496	—	14,14	112,62	1,52	88,79	,8961
18	,86651	—	14,97	113,38	1,59	88,20	,8901
19	,86804	—	15,80	114,14	1,66	87,61	,8842
100 + 20	,86952	—	16,64	114,91	1,73	87,03	,8783
21	,87100	—	17,47	115,67	1,80	86,45	,8725
22	,87243	—	18,30	116,43	1,87	85,88	,8668
23	,87384	—	19,13	117,19	1,94	85,32	,8612
24	,87522	—	19,96	117,96	2,00	84,77	,8556
100 + 25	,87658	—	20,79	118,73	2,06	84,23	,8500
26	,87791	—	21,63	119,50	2,13	83,69	,8445
27	,87922	—	22,46	120,27	2,19	83,15	,8392
28	,88051	—	23,29	121,04	2,25	82,62	,8339
29	,88177	—	24,13	121,81	2,32	82,09	,8286
100 + 30	,88300	—	24,96	122,58	2,38	81,58	,8233
31	,88423	—	25,78	123,36	2,42	81,07	,8182
32	,88543	—	26,61	124,13	2,48	80,56	,8131
33	,88662	—	27,44	124,90	2,54	80,07	,8081
34	,88779	—	28,29	125,67	2,62	79,58	,8031
100 + 35	,88894	—	29,12	126,45	2,67	79,09	,7981
36	,89007	—	29,95	127,22	2,73	78,61	,7933
37	,89118	—	30,78	127,99	2,79	78,13	,7885
38	,89227	—	31,61	128,77	2,84	77,66	,7837
39	,89335	—	32,44	129,55	2,89	77,19	,7790
100 + 40	,89440	—	33,28	130,33	2,95	76,73	,7744
41	,89546	—	34,11	131,10	3,01	76,28	,7698
42	,89650	—	34,94	131,88	3,06	75,83	,7653
43	,89752	—	35,77	132,65	3,12	75,38	,7608
44	,89853	—	36,60	133,43	3,17	74,94	,7563
100 + 45	,89953	—	37,43	134,21	3,22	74,51	,7519
46	,90051	—	38,26	134,99	3,27	74,08	,7476
47	,90145	—	39,10	135,77	3,33	73,65	,7433
48	,90240	—	39,93	136,55	3,38	73,23	,7391
49	,90333	—	40,76	137,33	3,43	72,81	,7349

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90424	100	41,59	138,12	3,47	72,40	,7367
51	,90513	—	42,42	138,90	3,52	71,99	,7266
52	,90600	—	43,25	139,69	3,56	71,59	,7225
53	,90686	—	44,08	140,47	3,61	71,19	,7184
54	,90771	—	44,92	141,26	3,66	70,79	,7145
100 + 55	,90855	—	45,75	142,04	3,71	70,40	,7105
56	,90937	—	46,58	142,83	3,75	70,01	,7066
57	,91019	—	47,41	143,62	3,79	69,63	,7027
58	,91098	—	48,24	144,40	3,84	69,25	,6990
59	,91176	—	49,08	145,19	3,89	68,87	,6952
100 + 60	,91254	—	49,90	145,98	3,92	68,50	,6913
61	,91331	—	50,74	146,77	3,97	68,13	,6877
62	,91407	—	51,57	147,56	4,01	67,77	,6840
63	,91482	—	52,40	148,35	4,05	67,41	,6803
64	,91555	—	53,23	149,14	4,09	67,05	,6766
100 + 65	,91627	—	54,07	149,93	4,14	66,70	,6731
66	,91699	—	54,90	150,72	4,18	66,35	,6696
67	,91771	—	55,73	151,51	4,22	66,00	,6661
68	,91842	—	56,56	152,30	4,26	65,66	,6627
69	,91912	—	57,40	153,09	4,31	65,32	,6592
100 + 70	,91980	—	58,23	153,88	4,35	64,98	,6558
71	,92047	—	59,06	154,67	4,39	64,65	,6524
72	,92114	—	59,89	155,47	4,42	64,32	,6491
73	,92179	—	60,72	156,26	4,46	63,99	,6458
74	,92243	—	61,55	157,05	4,50	63,67	,6426
100 + 75	,92305	—	62,39	157,85	4,54	63,35	,6394
76	,92370	—	63,22	158,64	4,58	63,03	,6361
77	,92432	—	64,05	159,44	4,61	62,72	,6330
78	,92493	—	64,88	160,23	4,65	62,41	,6299
79	,92553	—	65,71	161,02	4,69	62,10	,6268
100 + 80	,92613	—	66,55	161,82	4,73	61,80	,6237
81	,92673	—	67,37	162,61	4,76	61,49	,6206
82	,92731	—	68,20	163,41	4,79	61,19	,6176
83	,92788	—	69,05	164,21	4,84	60,89	,6146
84	,92846	—	69,87	165,01	4,86	60,60	,6116
100 + 85	,92902	—	70,70	165,79	4,91	60,31	,6087
86	,92958	—	71,53	166,60	4,93	60,02	,6058
87	,93017	—	72,37	167,40	4,97	59,74	,6029
88	,93067	—	73,20	168,19	5,01	59,46	,6001
89	,93121	—	74,03	168,99	5,04	59,18	,5973
100 + 90	,93173	—	74,87	169,79	5,08	58,90	,5944
91	,93225	—	75,70	170,59	5,11	58,62	,5916
92	,93175	—	76,53	171,39	5,14	58,35	,5888
93	,93325	—	77,37	172,19	5,18	58,08	,5861
94	,93375	—	78,19	172,99	5,20	57,81	,5834
100 + 95	,93424	—	79,02	173,79	5,23	57,54	,5807
96	,93472	—	79,84	174,58	5,26	57,28	,5781
97	,93520	—	80,67	175,38	5,29	57,02	,5755
98	,93568	—	81,50	176,17	5,33	56,76	,5729
99	,93615	—	82,34	176,98	5,36	56,50	,5703

TABLE II. HEAT 44°.

I. Water and Spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,93662	100	83,18	177,79	5,39	56,24	,5676	100 + 50	,96311	100	166,37	259,35	7,02	38,56	,3891
99	,93710	—	84,04	178,60	5,44	55,99	,5650	49	,96368	—	169,77	262,72	7,05	38,06	,3842
98	,93757	—	84,89	179,43	5,46	55,73	,5624	48	,96424	—	173,30	266,24	7,06	37,56	,3791
97	,93804	—	85,76	180,27	5,49	55,47	,5598	47	,96480	—	176,99	269,91	7,08	37,05	,3740
96	,93852	—	86,65	181,13	5,52	55,21	,5571	46	,96536	—	180,83	273,74	7,09	36,53	,3687
100 + 95	,93900	—	87,56	182,00	5,56	54,94	,5545	100 + 45	,96592	—	184,86	277,75	7,11	35,00	,3634
94	,93947	—	88,49	182,90	5,59	54,67	,5518	44	,96647	—	189,06	281,94	7,12	35,46	,3580
93	,93994	—	89,44	183,82	5,62	54,40	,5491	43	,96702	—	193,46	286,34	7,12	34,92	,3525
92	,94041	—	90,41	184,77	5,64	54,12	,5462	42	,96757	—	198,06	290,95	7,11	34,37	,3469
91	,94088	—	91,41	185,73	5,68	53,84	,5434	41	,96812	—	202,89	295,77	7,12	33,81	,3412
100 + 90	,94136	—	92,43	186,72	5,71	53,55	,5405	100 + 40	,96865	—	207,96	300,83	7,13	33,24	,3355
89	,94186	—	93,47	187,71	5,76	53,26	,5377	39	,96919	—	213,29	306,18	7,11	32,66	,3296
88	,94236	—	94,53	188,75	5,78	52,97	,5348	38	,96973	—	218,90	311,81	7,09	32,07	,3237
87	,94286	—	95,61	189,80	5,81	52,68	,5318	37	,97026	—	224,83	317,74	7,09	31,47	,3177
86	,94337	—	96,72	190,89	5,83	52,39	,5288	36	,97079	—	231,07	324,01	7,06	30,86	,3115
100 + 85	,94388	—	97,86	191,98	5,88	52,09	,5257	100 + 35	,97132	—	237,67	330,62	7,05	30,25	,3052
84	,94439	—	99,03	193,12	5,91	51,79	,5226	34	,97186	—	244,66	337,64	7,02	29,62	,2989
83	,94490	—	100,22	194,28	5,94	51,48	,5195	33	,97240	—	252,07	345,10	6,97	28,98	,2925
82	,94540	—	101,45	195,47	5,98	51,16	,5164	32	,97294	—	259,96	353,02	6,94	28,33	,2859
81	,94593	—	102,69	196,68	6,01	50,84	,5132	31	,97348	—	268,34	361,43	6,91	27,67	,2792
100 + 80	,94644	—	103,97	197,94	6,03	50,52	,5099	100 + 30	,97402	—	277,29	370,41	6,88	27,00	,2724
79	,94697	—	105,29	199,22	6,07	50,19	,5066	29	,97456	—	286,84	380,04	6,80	26,31	,2655
78	,94750	—	106,64	200,53	6,11	49,86	,5033	28	,97511	—	297,09	390,34	6,75	25,62	,2586
77	,94803	—	108,03	201,88	6,15	49,53	,4999	27	,97567	—	308,09	401,42	6,67	24,91	,2515
76	,94855	—	109,45	203,27	6,18	49,19	,4965	26	,97623	—	319,95	413,34	6,61	24,19	,2442
100 + 75	,94909	—	110,91	204,69	6,22	48,85	,4930	100 + 25	,97680	—	332,74	426,18	6,56	23,46	,2368
74	,94963	—	112,41	206,16	6,25	48,50	,4895	24	,97740	—	346,60	440,12	6,48	22,72	,2293
73	,95017	—	113,96	207,65	6,31	48,15	,4859	23	,97800	—	361,67	455,28	6,39	21,96	,2217
72	,95071	—	115,53	209,20	6,33	47,80	,4824	22	,97862	—	378,12	471,80	6,32	21,19	,2139
71	,95126	—	117,16	210,80	6,36	47,44	,4788	21	,97926	—	396,12	489,90	6,22	20,41	,2060
100 + 70	,95180	—	118,83	212,44	6,39	47,07	,4751	100 + 20	,97991	—	415,93	509,80	6,13	19,62	,1980
69	,95236	—	120,55	214,13	6,42	46,70	,4713	19	,98057	—	437,82	531,80	6,02	18,81	,1897
68	,95291	—	122,32	215,86	6,46	46,32	,4675	18	,98125	—	462,15	556,24	5,91	17,98	,1814
67	,95347	—	124,14	217,65	6,49	45,94	,4637	17	,98196	—	489,33	583,55	5,78	17,14	,1729
66	,95403	—	126,03	219,50	6,53	45,56	,4598	16	,98269	—	519,92	614,26	5,66	16,28	,1643
100 + 65	,95459	—	127,97	221,40	6,57	45,17	,4558	100 + 15	,98345	—	554,58	649,07	5,51	15,41	,1555
64	,95515	—	130,07	223,37	6,60	44,77	,4519	14	,98424	—	594,19	688,83	5,36	14,52	,1465
63	,95571	—	132,03	225,40	6,63	44,37	,4478	13	,98506	—	639,85	734,70	5,15	13,61	,1374
62	,95628	—	134,16	227,49	6,67	43,96	,4436	12	,98593	—	693,22	788,18	5,04	12,69	,1280
61	,95684	—	136,37	229,67	6,70	43,54	,4394	11	,98683	—	756,23	851,38	4,85	11,74	,1185
100 + 60	,95740	—	138,64	231,90	6,74	43,12	,4352	100 + 10	,98778	—	831,86	927,16	4,70	10,78	,1088
59	,95797	—	140,99	234,22	6,77	42,69	,4309	9	,98879	—	924,29	1019,81	4,48	9,80	,0990
58	,95855	—	143,41	236,61	6,80	42,26	,4265	8	,98984	—	1039,83	1135,54	4,29	8,81	,0889
57	,95915	—	145,93	239,10	6,83	41,82	,4220	7	,99097	—	1188,38	1284,30	4,08	7,79	,0786
56	,95969	—	148,55	241,68	6,87	41,37	,4176	6	,99215	—	1386,44	1482,57	3,87	6,74	,0681
100 + 55	,96026	—	151,24	244,35	6,89	40,92	,4130	100 + 5	,99340	—	1663,73	1760,09	3,64	5,68	,0573
54	,96084	—	154,03	247,11	6,92	40,46	,4085	4	,99472	—	2079,65	2176,26	3,39	4,60	,0464
53	,96141	—	156,91	249,99	6,92	40,00	,4038	3	,99612	—	2772,87	2869,71	3,16	3,48	,0352
52	,96197	—	159,94	252,99	6,95	39,53	,3990	2	,99762	—	4159,23	4256,39	2,84	2,35	,0237
51	,96255	—	163,09	256,10	6,99	39,05	,3941	1	,99921	—	8318,63	8415,96	2,67	1,19	,0120

TABLE I. HEAT 45°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83214	100	—	100,00	—	100,00	1,0087
1	,83444	—	0,83	100,72	0,11	99,28	1,0014
2	,83669	—	1,66	101,44	0,22	98,58	,9943
3	,83888	—	2,49	102,17	0,32	97,88	,9872
4	,84102	—	3,32	102,90	0,42	97,18	,9802
100 + 5	,84310	—	4,16	103,63	0,53	96,49	,9733
6	,84513	—	4,99	104,37	0,62	95,81	,9664
7	,84711	—	5,82	105,11	0,71	95,14	,9596
8	,84904	—	6,65	105,85	0,80	94,47	,9529
9	,85093	—	7,48	106,59	0,89	93,81	,9463
100 + 10	,85277	—	8,31	107,34	0,97	93,16	,9397
11	,85456	—	9,14	108,09	1,05	92,52	,9332
12	,85630	—	9,98	108,84	1,14	91,88	,9268
13	,85801	—	10,81	109,59	1,22	91,25	,9204
14	,85968	—	11,54	110,35	1,29	90,63	,9141
100 + 15	,86131	—	12,47	111,10	1,37	90,01	,9078
16	,86292	—	13,30	111,86	1,44	89,39	,9017
17	,86450	—	14,13	112,62	1,51	88,79	,8956
18	,86605	—	14,96	113,38	1,58	88,20	,8896
19	,86758	—	15,79	114,14	1,65	87,61	,8837
100 + 20	,86905	—	16,63	114,90	1,73	87,03	,8778
21	,87054	—	17,46	115,66	1,80	86,46	,8721
22	,87198	—	18,29	116,42	1,87	85,89	,8664
23	,87339	—	19,12	117,19	1,93	85,33	,8607
24	,87477	—	19,95	117,96	1,99	84,78	,8551
100 + 25	,87613	—	20,78	118,72	2,06	84,23	,8496
26	,87746	—	21,62	119,49	2,13	83,69	,8441
27	,87877	—	22,45	120,26	2,19	83,15	,8387
28	,88005	—	23,28	121,03	2,25	82,62	,8334
29	,88131	—	24,11	121,80	2,31	82,10	,8281
100 + 30	,88255	—	24,94	122,57	2,37	81,58	,8229
31	,88377	—	25,77	123,35	2,42	81,07	,8177
32	,88498	—	26,60	124,12	2,48	80,57	,8126
33	,88617	—	27,43	124,89	2,54	80,07	,8076
34	,88734	—	28,27	125,66	2,61	79,58	,8026
100 + 35	,88849	—	29,10	126,44	2,66	79,09	,7977
36	,88962	—	29,93	127,21	2,72	78,61	,7929
37	,89073	—	30,76	127,99	2,77	78,13	,7881
38	,89182	—	31,59	128,76	2,83	77,66	,7833
39	,89290	—	32,42	129,54	2,88	77,19	,7786
100 + 40	,89396	—	33,26	130,32	2,94	76,73	,7740
41	,89502	—	34,09	131,09	3,00	76,28	,7694
42	,89606	—	34,92	131,87	3,05	75,83	,7649
43	,89708	—	35,75	132,65	3,10	75,39	,7604
44	,89809	—	36,58	133,42	3,16	74,95	,7560
100 + 45	,89909	—	37,41	134,20	3,21	74,51	,7516
46	,90007	—	38,24	134,98	3,26	74,08	,7472
47	,90102	—	39,08	135,76	3,32	73,66	,7429
48	,90196	—	39,91	136,54	3,37	73,24	,7387
49	,90289	—	40,74	137,32	3,42	72,82	,7345

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90380	100	41,57	138,11	3,46	72,41	,7303
51	,90469	—	42,40	138,89	3,51	72,00	,7262
52	,90557	—	43,23	139,68	3,55	71,59	,7221
53	,90643	—	44,06	140,46	3,60	71,19	,7181
54	,90728	—	44,89	141,25	3,64	70,80	,7141
100 + 55	,90812	—	45,73	142,03	3,70	70,41	,7102
56	,90894	—	46,56	142,82	3,74	70,02	,7063
57	,90975	—	47,39	143,61	3,78	69,63	,7024
58	,91054	—	48,22	144,39	3,83	69,25	,6986
59	,91132	—	49,05	145,18	3,87	68,88	,6948
100 + 60	,91211	—	49,88	145,97	3,91	68,51	,6910
61	,91287	—	50,72	146,76	3,96	68,14	,6873
62	,91363	—	51,55	147,55	4,00	67,77	,6836
63	,91438	—	52,38	148,34	4,04	67,41	,6799
64	,91511	—	53,21	149,13	4,08	67,05	,6763
100 + 65	,91584	—	54,04	149,92	4,12	66,70	,6728
66	,91656	—	54,87	150,71	4,16	66,35	,6693
67	,91728	—	55,70	151,50	4,20	66,00	,6658
68	,91799	—	56,53	152,29	4,24	65,66	,6623
69	,91869	—	57,37	153,08	4,29	65,33	,6589
100 + 70	,91937	—	58,20	153,87	4,33	64,99	,6555
71	,92004	—	59,03	154,66	4,37	64,66	,6521
72	,92071	—	59,86	155,46	4,40	64,33	,6488
73	,92136	—	60,69	156,25	4,44	64,00	,6455
74	,92200	—	61,52	157,04	4,48	63,68	,6423
100 + 75	,92264	—	62,36	157,83	4,53	63,36	,6391
76	,92327	—	63,19	158,63	4,56	63,04	,6359
77	,92389	—	64,02	159,42	4,60	62,73	,6327
78	,92450	—	64,85	160,22	4,63	62,42	,6296
79	,92510	—	65,68	161,01	4,67	62,11	,6265
100 + 80	,92570	—	66,51	161,81	4,70	61,80	,6234
81	,92629	—	67,34	162,60	4,74	61,50	,6203
82	,92688	—	68,17	163,40	4,77	61,20	,6173
83	,92745	—	69,01	164,19	4,82	60,90	,6143
84	,92803	—	69,84	164,99	4,85	60,61	,6113
100 + 85	,92859	—	70,67	165,78	4,89	60,32	,6084
86	,92915	—	71,50	166,58	4,92	60,03	,6055
87	,92970	—	72,33	167,38	4,95	59,75	,6026
88	,93024	—	73,16	168,17	4,99	59,46	,5998
89	,93078	—	73,99	168,97	5,02	59,18	,5970
100 + 90	,93131	—	74,83	169,77	5,06	58,90	,5941
91	,93182	—	75,66	170,57	5,09	58,63	,5913
92	,93233	—	76,49	171,37	5,12	58,35	,5886
93	,93283	—	77,32	172,17	5,15	58,08	,5859
94	,93333	—	78,15	172,97	5,18	57,81	,5832
100 + 95	,93382	—	78,98	173,77	5,21	57,55	,5805
96	,93430	—	79,80	174,56	5,24	57,29	,5778
97	,93478	—	80,63	175,35	5,28	57,03	,5752
98	,93526	—	81,46	176,15	5,31	56,77	,5726
99	,93574	—	82,30	176,96	5,34	56,51	,5700

TABLE II. HEAT 45°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,93621	100	83,14	177,76	5,38	56,25	,5674	100 + 50	,96280	100	166,28	259,29	6,99	38,57	,3890
99	,93669	—	83,99	178,58	5,41	56,00	,5648	49	,96337	—	169,68	262,66	7,02	38,07	,3840
98	,93717	—	84,85	179,41	5,44	55,74	,5622	48	,96394	—	173,21	266,18	7,03	37,57	,3789
97	,93764	—	85,72	180,25	5,47	55,48	,5596	47	,96450	—	176,90	269,85	7,05	37,06	,3738
96	,93812	—	86,61	181,11	5,50	55,22	,5569	46	,96507	—	180,74	273,68	7,06	36,54	,3686
100 + 95	,93860	—	87,52	181,98	5,54	54,95	,5543	100 + 45	,96563	—	184,76	277,68	7,08	36,01	,3633
94	,93907	—	88,45	182,88	5,57	54,68	,5515	44	,96619	—	188,96	281,87	7,09	35,47	,3579
93	,93954	—	89,40	183,80	5,60	54,41	,5488	43	,96674	—	193,36	286,26	7,10	34,93	,3524
92	,94001	—	90,37	184,75	5,62	54,13	,5460	42	,96730	—	197,96	290,87	7,09	34,38	,3468
91	,94048	—	91,36	185,71	5,65	53,85	,5432	41	,96785	—	202,78	295,69	7,09	33,82	,3411
100 + 90	,94096	—	92,38	186,69	5,69	53,56	,5403	100 + 40	,96840	—	207,85	300,75	7,10	33,25	,3354
89	,94146	—	93,42	187,69	5,73	53,27	,5374	39	,96894	—	213,18	306,09	7,09	32,67	,3295
88	,94196	—	94,48	188,72	5,76	52,98	,5345	38	,96948	—	218,79	311,71	7,08	32,08	,3236
87	,94246	—	95,56	189,78	5,78	52,69	,5315	37	,97002	—	224,71	317,64	7,07	31,48	,3176
86	,94297	—	96,67	190,86	5,81	52,39	,5285	36	,97056	—	230,95	323,91	7,04	30,87	,3114
100 + 85	,94348	—	97,81	191,96	5,85	52,09	,5254	100 + 35	,97110	—	237,55	330,52	7,03	30,26	,3052
84	,94399	—	98,98	193,09	5,89	51,79	,5223	34	,97164	—	244,53	337,53	7,00	29,63	,2988
83	,94450	—	100,17	194,25	5,92	51,48	,5192	33	,97219	—	251,94	344,98	6,96	28,99	,2924
82	,94501	—	101,39	195,44	5,95	51,17	,5161	32	,97274	—	259,82	352,90	6,92	28,34	,2859
81	,94553	—	102,64	196,66	5,98	50,85	,5129	31	,97329	—	268,20	361,31	6,89	27,68	,2792
100 + 80	,94605	—	103,92	197,91	6,01	50,53	,5097	100 + 30	,97384	—	277,14	370,28	6,86	27,01	,2724
79	,94658	—	105,24	199,19	6,05	50,20	,5064	29	,97439	—	286,69	379,90	6,79	26,32	,2655
78	,94711	—	106,59	200,50	6,09	49,87	,5031	28	,97494	—	296,93	390,20	6,73	25,63	,2585
77	,94764	—	107,98	201,85	6,13	49,54	,4997	27	,97551	—	307,93	401,27	6,66	24,92	,2514
76	,94817	—	109,40	203,24	6,16	49,20	,4963	26	,97608	—	319,78	413,19	6,59	24,20	,2441
100 + 75	,94871	—	110,86	204,66	6,20	48,86	,4928	100 + 25	,97666	—	332,57	426,01	6,56	23,47	,2368
74	,94925	—	112,35	206,12	6,23	48,51	,4893	24	,97726	—	346,42	439,94	6,48	22,73	,2293
73	,94979	—	113,89	207,62	6,27	48,16	,4858	23	,97787	—	361,48	455,09	6,39	21,97	,2217
72	,95033	—	115,47	209,17	6,30	47,81	,4822	22	,97850	—	377,92	471,60	6,32	21,20	,2139
71	,95088	—	117,10	210,77	6,33	47,45	,4786	21	,97914	—	395,91	489,69	6,22	20,42	,2060
100 + 70	,95143	—	118,77	212,41	6,36	47,08	,4749	100 + 20	,97980	—	415,71	509,58	6,13	19,62	,1979
69	,95199	—	120,49	214,09	6,40	46,71	,4711	19	,98047	—	437,59	531,56	6,03	18,81	,1897
68	,95254	—	122,26	215,82	6,44	46,33	,4673	18	,98116	—	461,90	555,99	5,91	17,98	,1814
67	,95310	—	124,08	217,61	6,47	45,95	,4635	17	,98187	—	489,07	583,28	5,79	17,14	,1729
66	,95367	—	125,96	219,46	6,50	45,56	,4596	16	,98261	—	519,63	613,97	5,66	16,29	,1643
100 + 65	,95423	—	127,90	221,36	6,54	45,17	,4557	100 + 15	,98338	—	554,28	648,76	5,52	15,41	,1555
64	,95479	—	129,90	223,32	6,58	44,78	,4517	14	,98417	—	593,87	688,50	5,37	14,52	,1465
63	,95535	—	131,96	225,35	6,61	44,38	,4476	13	,98500	—	639,55	734,34	5,21	13,61	,1374
62	,95592	—	134,09	227,45	6,64	43,97	,4434	12	,98587	—	692,85	787,79	5,06	12,69	,1280
61	,95649	—	136,30	229,62	6,68	43,55	,4392	11	,98678	—	755,83	850,95	4,88	11,75	,1185
100 + 60	,95705	—	138,57	231,85	6,72	43,13	,4350	100 + 10	,98774	—	831,42	926,69	4,73	10,79	,1088
59	,95762	—	140,91	234,17	6,74	42,70	,4307	9	,98875	—	923,80	1019,29	4,51	9,81	,0990
58	,95820	—	143,34	236,57	6,77	42,27	,4263	8	,98981	—	1039,27	1134,95	4,32	8,81	,0889
57	,95878	—	145,86	239,05	6,81	41,83	,4219	7	,99094	—	1187,74	1283,62	4,12	7,79	,0786
56	,95935	—	148,47	241,63	6,84	41,38	,4174	6	,99213	—	1385,70	1481,78	3,92	6,75	,0681
100 + 55	,95993	—	151,16	244,30	6,86	40,93	,4129	100 + 5	,99338	—	1662,83	1759,14	3,69	5,69	,0573
54	,96051	—	153,93	247,06	6,87	40,47	,4083	4	,99470	—	2078,54	2175,09	3,45	4,60	,0464
53	,96108	—	156,83	249,93	6,90	40,01	,4036	3	,99611	—	2771,39	2868,16	3,23	3,49	,0352
52	,96165	—	159,86	252,93	6,93	39,54	,3988	2	,99761	—	4156,99	4254,09	2,90	2,35	,0237
51	,96223	—	163,01	256,05	6,96	39,06	,3939	1	,99919	—	8314,17	8411,41	2,76	1,19	,0120

TABLE I. HEAT 46°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Spirit and water by weight.	II. Specific gravity.	III Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.								Sp. + W							
100 + 0	,83167	100	—	100,00	—	100,00	1,0081	100 + 50	,90336	100	41,55	138,09	3,46	72,41	,7300
1	,83397	—	0,83	100,72	0,11	99,28	1,0009	51	,90426	—	42,38	138,87	3,51	72,01	,7259
2	,83622	—	1,66	101,44	0,22	98,58	,9938	52	,90514	—	43.20	139,66	3,54	71,60	,7218
3	,83842	—	2,49	102,17	0,32	97,88	,9867	53	,90600	—	44 03	140.44	3,59	71,20	,7178
4	,84056	—	3,32	102,90	0,42	97,18	,9797	54	,90685	—	44 87	141 23	3,64	70.81	,7138
100 + 5	,84263	—	4,16	103,63	0,53	96,49	,9727	100 + 55	,90768	—	45,70	142.01	3,69	70 42	,7098
6	,84467	—	4,99	104,37	0,62	95,81	,9659	56	,90851	—	46 53	142,80	3.73	70,03	,7059
7	,84665	—	5,82	105,11	0,71	95,14	,9591	57	,90932	—	47,36	143,59	3,77	69,64	,7021
8	,84858	—	6,65	105,85	0,80	94,47	,9524	58	,91011	—	48,19	144,37	3 82	69.26	,6983
9	,85046	—	7,48	106.59	0,89	93,81	,9458	59	,91089	—	49.02	145,16	3,86	68,89	,6945
100 + 10	,85230	—	8,31	107,34	0,97	93,16	,9392	100 + 60	,91169	—	49.85	145,95	3 90	68.51	,6907
11	,85410	—	9,14	108,09	1,05	92,52	,9327	61	,91244	—	50,69	146.74	3 95	68,14	,6870
12	,85584	—	9,97	108,84	1,13	91,88	,9263	62	,91320	—	51.52	147,53	3 99	67,78	,6833
13	,85755	—	10,81	109,59	1-22	91,25	,9199	63	,91395	—	52,35	148,32	4,03	67.42	,6796
14	,85922	—	11,63	110.35	1,28	90,63	,9136	64	,91468	—	53.18	149,11	4.07	67,06	,6760
100 + 15	,86085	—	12,46	111,10	1,36	90,01	,9074	100 + 65	,91542	—	54.01	149,90	4 11	66,71	,6725
16	,86247	—	13,30	111,86	1,44	89,40	,9013	66	,91614	—	54,84	150,69	4,15	66,36	,6690
17	,86404	—	14,12	112,62	1,50	88,79	,8952	67	,91686	—	55,67	151,48	4 19	66,01	,6655
18	,86559	—	14,95	113 38	1,57	88 20	,8892	68	,91757	—	56,50	152,27	4 23	65,67	,6620
19	,86712	—	15,78	114.14.	1,64	87.61	,8833	69	,91826	—	57,33	153,06	4,27	65,33	,6586
100 + 20	,86859	—	16,62	114,90	1,72	87.03	,8774	100 + 70	,91895	—	58,16	153 85	4 31	65,00	,6552
21	,87008	—	17,45	115,66	1,79	86,46	,8716	71	,91962	—	59,00	154,64	4,36	64 67	,6519
22	,87152	—	18,28	116,42	1,86	85,89	,8660	72	,92028	—	59,82	155.44	4 38	64,34	,6486
23	,87293	—	19,11	117,18	1 93	85,33	,8603	73	,92094	—	60,65	156 23	4.42	64,01	,6453
24	,87431	—	19,94	117,95	1,99	84,78	,8547	74	,92158	—	61,48	157,02	4.46	63,69	,6420
100 + 25	,87568	—	20,77	118,72	2,05	84,23	,8491	100 + 75	,92221	—	62,32	157,81	4 51	63,37	,6388
26	,87700	—	21,61	119,48	2,13	83,69	,8437	76	,92285	—	63 15	158,61	4.54	63,05	,6356
27	,87832	—	22,44	120.26	2,18	83,16	,8383	77	,92347	—	63,98	159,40	4.58	62,73	,6324
28	,87960	—	23,27	121,03	2,24	82,63	,8330	78	,92408	—	64.81	160,20	4,61	62,42	,6293
29	,88086	—	24,10	121,80	2,30	82,10	,8277	79	,92468	—	65,64	160,99	4,65	62,11	,6262
100 + 30	,88210	—	24,93	122,57	2,36	81,59	,8225	100 + 80	,92527	—	66,47	161.79	4,68	61,81	,6231
31	,88332	—	25,76	123,34	2,42	81,08	,8173	81	,92587	—	67,30	162,58	4,72	61 50	,6200
32	,88454	—	26,59	124,11	2,48	80,57	,8122	82	,92646	—	68,13	163,38	4,75	61 20	,6170
33	,88573	—	27,42	124,88	2,54	80,07	,8072	83	,92703	—	68,97	164,17	4,80	60,91	,6140
34	,88690	—	28,25	125,65	2,60	79,58	,8022	84	,92761	—	69.80	164 98	4 82	60,61	,6111
100 + 35	,88804	—	29,09	126,43	2,66	79,10	,7973	100 + 85	,92816	—	70 63	165,76	4,87	60 32	,6081
36	,88917	—	29,91	127,20	2,71	78,62	,7925	86	,92873	—	71,46	166,57	4,89	60,03	,6053
37	,89029	—	30,74	127,98	2,76	78,14	,7877	87	,92928	—	72,29	167,36	4,93	59 75	,6024
38	,89138	—	31,57	128,75	2,82	77,67	,7829	88	,92982	—	73,12	168 16	4 98	59.47	,5996
39	,89246	—	32,40	129,53	2,87	77,20	,7782	89	,93036	—	73,95	168,95	5,00	59,19	,5967
100 + 40	,89351	—	33,24	130,31	2,93	76,74	,7736	100 + 90	,93089	—	74,79	169,75	5,04	58,91	,5939
41	,89458	—	34,07	131,08	2,99	76,29	,7691	91	,93140	—	75,62	170,55	5,07	58,64	,5910
42	,89562	—	34,90	131,86	3,04	75,84	,7646	92	,93192	—	76,45	171,34	5.11	58,36	,5883
43	,89664	—	35,73	132,64	3,09	75,39	,7601	93	,93242	—	77.28	172,15	5,13	58.09	,5856
44	,89765	—	36,56	133.41	3,15	74,95	,7557	94	,93292	—	78.10	172.95	5 15	57 82	,5830
100 + 45	,89864	—	37,39	134,19	3,20	74,52	,7512	100 + 95	,93341	—	78,93	173.74	5,19	57.56	,5802
46	,89962	—	38,22	134,97	3,25	74,09	,7469	96	,93389	—	79,75	174,53	5 22	57,30	,5776
47	,90058	—	39,05	135,75	3,30	73,66	,7426	97	,93437	—	80,59	175,33	5,26	57,04	,5750
48	,90152	—	39,88	136,53	3,35	73,24	,7384	98	,93485	—	81,41	176,13	5,28	56,78	,5724
49	,90245	—	40,72	137,31	3,41	72,82	,7342	99	,93533	—	82,25	176,93	5,32	56,52	,5698

TABLE II.

HEAT 46°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93580	100	83,09	177,74	5,35	56,26	,5672
99	,93629	—	83,94	178,55	5,39	56,00	,5646
98	,93676	—	84,80	179,38	5,42	55,74	,5619
97	,93724	—	85,67	180,22	5,45	55,48	,5593
96	,93772	—	86,56	181,08	5,48	55,22	,5567
100 + 95	,93820	—	87,47	181,95	5,52	54,95	,5540
94	,93307	—	88,40	182,85	5,55	54,69	,5513
93	,93914	—	89,35	183,77	5,58	54 41	,5486
92	,93961	—	90,32	184,72	5,60	54,14	,5458
91	,94008	—	91,31	185,68	5,63	53,86	,5430
100 + 90	,94057	—	92,33	186,67	5,66	53,57	,5400
89	,94106	—	93,37	187,66	5,71	53,28	,5372
88	,94156	—	94,43	188,70	5,73	52,99	,5343
87	,94207	—	95,51	189,75	5,76	52,70	,5313
86	,94258	—	96,62	190,84	5,78	52,40	,5283
100 + 85	,94309	—	97,75	191,93	5,82	52,10	,5252
84	,94360	—	98,92	193,07	5,85	51,80	,5221
83	,94411	—	100,12	194,22	5,90	51,49	,5190
82	,94462	—	101,33	195,41	5,92	51,17	,5159
81	,94514	—	102,58	196,63	5,95	50,86	,5127
100 + 80	,94560	—	103,86	197,88	5,98	50,54	,5094
79	,94620	—	105,18	199,16	6,02	50,21	,5062
78	,94673	—	106,53	200,47	6,06	49,88	,5029
77	,94727	—	107,92	201,81	6,11	49,54	,4995
76	,94780	—	109,34	203,21	6,13	49,21	,4961
100 + 75	,94834	—	110,80	204,62	6,18	48,87	,4926
74	,94888	—	112,29	206,08	6,21	48,52	,4892
73	,94942	—	113,82	207,58	6,24	48,17	,4857
72	,94996	—	115,40	209,13	6,27	47,81	,4821
71	,95051	—	117,03	210,73	6,30	47,46	,4784
100 + 70	,95106	—	118,70	212,37	6,33	47,09	,4747
69	,95162	—	120,42	214,05	6,37	46,72	,4710
68	,95218	—	122,19	215,78	6,41	46,34	,4672
67	,95274	—	124,01	217,57	6,44	45,96	,4634
66	,95331	—	125,89	219,42	6,47	45,57	,4595
100 + 65	,95387	—	127,83	221,31	6,53	45,18	,4555
64	,95444	—	129,83	223,28	6,55	44,79	,4515
63	,95500	—	131,89	225,31	6,58	44,38	,4475
62	,95557	—	134,02	227,41	6,61	43,98	,4433
61	,95615	—	136,22	229,58	6,64	43,56	,4391
100 + 60	,95671	—	138,49	231,81	6,68	43,14	,4349
59	,95728	—	140,83	234,12	6,71	42,71	,4306
58	,95787	—	143,26	236,52	6,74	42,28	,4262
57	,95845	—	145,78	239,00	6,78	41,84	,4218
56	,95902	—	148,39	241,58	6,81	41,39	,4173
100 + 55	,95959	—	151,08	244,25	6,83	40,94	,4127
54	,96019	—	153,85	247,01	6,84	40,48	,4082
53	,96076	—	156,74	249,87	6,87	40,02	,4035
52	,96134	—	159,77	252,87	6,90	39,55	,3987
51	,96192	—	162,92	255,99	6,93	39,06	,3938

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96250	100	166,19	259,22	6,97	38,57	,3889
49	,96307	—	169,59	262,60	6,99	38,08	,3839
48	,96364	—	173,11	266,11	7,00	37,58	,3788
47	,96421	—	176,80	269,78	7,02	37,07	,3737
46	,96478	—	180,64	273,61	7,03	36,55	,3685
100 + 45	,96535	—	184,66	277,60	7,06	36,02	,3632
44	,96591	—	188,86	281,79	7,07	35,48	,3578
43	,96647	—	193,25	286,18	7,07	34,94	,3523
42	,96703	—	197,85	290,78	7,07	34,39	,3467
41	,96759	—	202,67	295,60	7,07	33,83	,3410
100 + 40	,96814	—	207,74	300,66	7,08	33,26	,3353
39	,96869	—	213,06	305,99	7,07	32,68	,3295
38	,96923	—	218,67	311,61	7,06	32,09	,3235
37	,96978	—	224,59	317,53	7,06	31,49	,3175
36	,97033	—	230,82	323,80	7,02	30,88	,3113
100 + 35	,97087	—	237,42	330,41	7,01	30,27	,3051
34	,97142	—	244,40	337,42	6,98	29,64	,2988
33	,97198	—	251,80	344,86	6,94	29,00	,2924
32	,97253	—	259,68	352,77	6,91	28,35	,2858
31	,97309	—	268,05	361,18	6,87	27,69	,2792
100 + 30	,97364	—	276,99	370,14	6,85	27,02	,2724
29	,97420	—	286,53	379,76	6,77	26,33	,2655
28	,97476	—	296,77	390,05	6,72	25,64	,2585
27	,97534	—	307,76	401,11	6,65	24,93	,2514
26	,97692	—	319,60	413,02	6,58	24,21	,2441
100 + 25	,97650	—	332,39	425,83	6,56	23,48	,2367
24	,97712	—	346,23	439,75	6,48	22,74	,2293
23	,97773	—	361,28	454,89	6,39	21,98	,2217
22	,97837	—	377,71	471,39	6,32	21,21	,2139
21	,97902	—	395,70	489,47	6,23	20,43	,2060
100 + 20	,97968	—	415,48	509,35	6,13	19,63	,1979
19	,98036	—	437,35	531,32	6,03	18,82	,1897
18	,98106	—	461,65	555,73	5,92	17,99	,1814
17	,98177	—	488,81	583,00	5,81	17,15	,1729
16	,98252	—	519,35	613,68	5,67	16,29	,1643
100 + 15	,98329	—	553,98	648,44	5,54	15,42	,1555
14	,98409	—	593,55	688,16	5,39	14,53	,1465
13	,98493	—	639,21	733,97	5,24	13,62	,1374
12	,98580	—	692,48	787,39	5,09	12,70	,1280
11	,98672	—	755,42	850,52	4,92	11,75	,1185
100 + 10	,98768	—	830,97	926,21	4,76	10,79	,1088
9	,98870	—	923,30	1018,76	4,54	9,81	,0990
8	,98976	—	1038,71	1134,36	4,35	8,81	,0889
7	,99090	—	1187,10	1282,95	4,15	7,79	,0786
6	,99210	—	1384,96	1481,00	3,96	6,75	,0681
100 + 5	,99334	—	1661,94	1758,21	3,73	5,69	,0573
4	,99467	—	2077,42	2173,93	3,49	4,60	,0464
3	,99608	—	2769,91	2866,63	3,28	3,49	,0352
2	,99758	—	4154,78	4251,80	2,98	2,35	,0237
1	,99916	—	8309,71	8406,88	2,83	1,19	,0120

TABLE I. HEAT 47°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83120	100	—	100,00	—	100,00	1,0075
1	,83350	—	0,83	100,72	0,11	99,28	1,0004
2	,83575	—	1,66	101,44	0,22	98,58	,9933
3	,83795	—	2,49	102,17	0,32	97,88	,9862
4	,84009	—	3,32	102,90	0,42	97,18	,9792
100 + 5	,84216	—	4,16	103,63	0,53	96,49	,9722
6	,84420	—	4,98	104,37	0,61	95,81	,9654
7	,84618	—	5,81	105,11	0,70	95,14	,9586
8	,84811	—	6,64	105,85	0,80	94,47	,9519
9	,84999	—	7,47	106,59	0,88	93,81	,9453
100 + 10	,85183	—	8,30	107,34	0,96	93,16	,9387
11	,85363	—	9,13	108,09	1,04	92,52	,9322
12	,85538	—	9,97	108,84	1,13	91,88	,9258
13	,85709	—	10,80	109,59	1,21	91,25	,9194
14	,85876	—	11,63	110,34	1,27	90,63	,9131
100 + 15	,86039	—	12,46	111,09	1,37	90,01	,9069
16	,86201	—	13,29	111,85	1,44	89,40	,9008
17	,86358	—	14,11	112,61	1,50	88,80	,8947
18	,86513	—	14,94	113,37	1,57	88,21	,8887
19	,86666	—	15,77	114,13	1,64	87,62	,8828
100 + 20	,86813	—	16,61	114,89	1,72	87,04	,8769
21	,86962	—	17,44	115,65	1,79	86,46	,8712
22	,87106	—	18,27	116,41	1,86	85,89	,8655
23	,87247	—	19,10	117,18	1,92	85,33	,8598
24	,87385	—	19,93	117,95	1,98	84,79	,8542
100 + 25	,87522	—	20,76	118,71	2,05	84,24	,8487
26	,87655	—	21,60	119,48	2,12	83,70	,8432
27	,87787	—	22,43	120,25	2,18	83,16	,8378
28	,87915	—	23,26	121,02	2,24	82,63	,8325
29	,88041	—	24,09	121,79	2,30	82,11	,8273
100 + 30	,88165	—	24,92	122,56	2,36	81,59	,8221
31	,88288	—	25,74	123,33	2,41	81,08	,8169
32	,88409	—	26,57	124,10	2,47	80,58	,8118
33	,88528	—	27,40	124,87	2,53	80,08	,8068
34	,88645	—	28,24	125,64	2,60	79,59	,8018
100 + 35	,88760	—	29,07	126,42	2,65	79,10	,7969
36	,88873	—	29,90	127,19	2,71	78,62	,7921
37	,88984	—	30,73	127,97	2,76	78,14	,7873
38	,89093	—	31,56	128,74	2,82	77,67	,7825
39	,89202	—	32,39	129,52	2,87	77,20	,7778
100 + 40	,89307	—	33,22	130,30	2,92	76,74	,7732
41	,89413	—	34,05	131,07	2,98	76,29	,7687
42	,89517	—	34,88	131,85	3,03	75,84	,7642
43	,89619	—	35,71	132,63	3,08	75,40	,7597
44	,89720	—	36,54	133,40	3,14	74,96	,7553
100 + 45	,89819	—	37,37	134,18	3,19	74,52	,7509
46	,89917	—	38,20	134,96	3,24	74,09	,7466
47	,90014	—	39,03	135,74	3,29	73,67	,7422
48	,90108	—	39,86	136,52	3,34	73,25	,7380
49	,90201	—	40,70	137,30	3,40	72,83	,7338

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of Bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90292	100	41,52	138,08	3,44	72,42	,7296
51	,90382	—	42,35	138,86	3,49	72,01	,7255
52	,90470	—	43,18	139,65	3,53	71,61	,7214
53	,90557	—	44,01	140,43	3,58	71,21	,7174
54	,90642	—	44,84	141,22	3,62	70,81	,7135
100 + 55	,90725	—	45,68	142,00	3,68	70,42	,7095
56	,90808	—	46,51	142,79	3,72	70,03	,7056
57	,90889	—	47,33	143,58	3,75	69,64	,7018
58	,90969	—	48,17	144,36	3,81	69,27	,6980
59	,91047	—	49,00	145,15	3,85	68,89	,6942
100 + 60	,91126	—	49,82	145,94	3,88	68,52	,6903
61	,91202	—	50,66	146,73	3,93	68,15	,6867
62	,91277	—	51,49	147,51	3,98	67,79	,6830
63	,91353	—	52,32	148,31	4,01	67,43	,6793
64	,91426	—	53,15	149,10	4,05	67,07	,6757
100 + 65	,91499	—	53,98	149,89	4,09	66,72	,6721
66	,91571	—	54,81	150,68	4,13	66,37	,6687
67	,91643	—	55,64	151,47	4,17	66,02	,6652
68	,91714	—	56,47	152,25	4,22	65,67	,6617
69	,91783	—	57,30	153,05	4,25	65,34	,6583
100 + 70	,91852	—	58,13	153,84	4,29	65,00	,6549
71	,91919	—	58,96	154,63	4,33	64,67	,6516
72	,91985	—	59,79	155,43	4,36	64,34	,6483
73	,92051	—	60,62	156,22	4,40	64,01	,6450
74	,92115	—	61,45	157,01	4,44	63,69	,6417
100 + 75	,92178	—	62,29	157,80	4,49	63,37	,6385
76	,92242	—	63,12	158,59	4,53	63,05	,6353
77	,92304	—	63,95	159,39	4,56	62,74	,6321
78	,92366	—	64,78	160,18	4,60	62,43	,6290
79	,92425	—	65,61	160,97	4,64	62,12	,6259
100 + 80	,92484	—	66,44	161,77	4,67	61,82	,6228
81	,92544	—	67,27	162,57	4,70	61,51	,6198
82	,92604	—	68,09	163,36	4,73	61,21	,6168
83	,92661	—	68,93	164,15	4,78	60,91	,6138
84	,92718	—	69,76	164,96	4,80	60,62	,6108
100 + 85	,92773	—	70,59	165,75	4,84	60,33	,6079
86	,92831	—	71,42	166,55	4,87	60,04	,6050
87	,92886	—	72,25	167,34	4,91	59,76	,6021
88	,92940	—	73,08	168,14	4,94	59,48	,5993
89	,92994	—	73,91	168,93	4,98	59,20	,5965
100 + 90	,93047	—	74,75	169,73	5,02	58,92	,5936
91	,93098	—	75,58	170,53	5,05	58,64	,5908
92	,93150	—	76,41	171,32	5,09	58,37	,5881
93	,93201	—	77,23	172,12	5,11	58,10	,5854
94	,93251	—	78,06	172,92	5,14	57,83	,5827
100 + 95	,93301	—	78,89	173,72	5,17	57,56	,5800
96	,93349	—	79,71	174,51	5,20	57,30	,5773
97	,93397	—	80,54	175,30	5,24	57,04	,5747
98	,93445	—	81,37	176,10	5,27	56,78	,5721
99	,93492	—	82,21	176,91	5,30	56,53	,5696

TABLE II. HEAT 47°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93539	100	83,05	177,71	5,34	56.27	,5669
99	,93588	—	83,90	178,53	5,37	56,01	,5643
98	,93636	—	84,76	179,36	5,40	55,75	,5617
97	,93683	—	85,63	180,20	5,43	55,49	,5592
96	,93731	—	86,52	181,06	5,46	55.23	,5565
100 + 95	,93780	—	87,42	181,93	5,49	54,96	,5538
94	,93827	—	88,35	182,83	5,52	54,70	,5511
93	,93874	—	89,30	183,75	5,55	54,42	,5483
92	,93921	—	90,27	184,70	5,57	54,15	,5455
91	,93968	—	91.26	185,66	5,60	53,87	,5427
100 + 90	,94017	—	92,28	186,64	5,64	53,58	,5398
89	,94066	—	93.32	187,64	5,68	53,29	,5369
88	,94116	—	94.38	188,67	5,71	53,00	,5340
87	,94167	—	95,46	189.73	5,73	52,71	,5310
86	,94218	—	96.57	190,81	5,76	52.41	,5280
100 + 85	,94269	—	97,70	191,90	5,80	52,11	,5250
84	,94320	—	98,87	193,04	5,83	51,81	,5219
83	,94372	—	100,06	194,19	5,87	51.50	,5188
82	,94424	—	101,28	195,38	5,90	51,18	,5157
81	,94475	—	102,53	196,60	5,93	50,87	,5125
100 + 80	,94528	—	103,81	197,84	5,97	50,54	,5092
79	,94582	—	105,13	199,12	6,01	50,22	,5060
78	,94635	—	106.47	200,43	6,04	49,89	,5027
77	,94689	—	107,86	201,78	6,08	49.55	,4993
76	,94742	—	109.28	203.17	6.11	49 22	,4959
100 + 75	,94797	—	110,74	204,59	6,15	48,88	,4925
74	,94850	—	112,23	206,05	6,18	48,53	,4890
73	,94904	—	113.76	207,55	6,21	48,18	,4855
72	,94959	—	115.34	209,09	6,25	47,82	,4819
71	,95014	—	116,97	210,70	6,27	47.47	,4782
100 + 70	,95069	—	118,64	212,33	6,31	47,10	,4745
69	,95125	—	120,35	214,01	6,34	46,73	,4708
68	,95181	—	122,12	215.74	6,38	46,35	,4670
67	,95237	—	123.94	217,53	6,41	45,97	,4632
66	,95294	—	125.82	219,37	6,45	45,58	,4593
100 + 65	,95351	—	127,76	221,27	6,49	45,19	,4553
64	,95408	—	129,76	223,24	6,52	44,79	,4513
63	,95464	—	131,82	225,26	6,56	44,39	,4473
62	,95522	—	133.95	227.36	6,59	43,99	,4431
61	,95580	—	136.14	229,53	6,61	43.57	,4389
100 + 60	,95637	—	138.42	231,76	6.66	43,15	,4347
59	,95695	—	140,75	234,07	6,68	42,72	,4304
58	,95753	—	143,19	236,47	6,72	42,29	,4260
57	,95812	—	145,70	238,94	6,76	41,85	,4216
56	,95870	—	148,31	241.52	6,79	41,40	,4172
100 + 55	,95927	—	151,00	244,19	6,81	40,95	,4126
54	,95987	—	153,77	246,95	6,82	40,49	,4080
53	,96045	—	156,66	249,81	6,85	40,02	,4033
52	,96102	—	159.68	252,81	6,87	39,55	,3985
51	,96161	—	162,83	255,92	6,91	39,07	,3937

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96219	100	166,10	259,16	6,94	38,58	,3888
49	,96276	—	169,50	262,53	6,97	38,09	,3838
48	,96334	—	173,02	266,04	6,98	37,59	,3787
47	,96391	—	176,70	269,70	7,00	37,08	,3736
46	,96449	—	180,55	273,53	7,02	36,56	,3684
100 + 45	,96507	—	184,56	277,53	7,03	36,03	,3630
44	,96562	—	188,76	281,71	7,05	35,49	,3577
43	,96619	—	193,15	286,10	7,05	34,95	,3522
42	,96675	—	197,74	290,70	7,04	34,40	,3466
41	,96732	—	202,56	295,52	7,04	33,84	,3409
100 + 40	,96788	—	207,63	300,57	7,06	33,27	,3352
39	,96843	—	212,95	305,89	7,06	32,69	,3294
38	,96898	—	218,55	311,51	7,04	32,10	,3234
37	,96953	—	224,47	317,43	7,04	31,50	,3174
36	,97009	—	230,70	323,68	7,02	30,89	,3112
100 + 35	,97064	—	237,29	330,29	7,00	30,28	,3050
34	,97119	—	244,27	337,30	6,97	29,65	,2987
33	,97176	—	251,67	344,73	6,94	29.01	,2923
32	,97231	—	259,54	352,64	6,90	28,36	,2858
31	,97288	—	267,91	361,04	6,87	27,70	,2791
100 + 30	,97344	—	276,84	370,00	6,84	27,03	,2723
29	,97401	—	286,38	379,61	6,77	26,34	,2654
28	,97458	—	296,61	389,90	6,71	25,65	,2584
27	,97516	—	307,59	400,94	6,65	24,94	,2513
26	,97675	—	319.43	412,85	6,58	24,22	,2440
100 + 25	,97634	—	332,21	425,66	6,55	23,49	,2367
24	,97697	—	346,05	439,56	6,49	22,75	,2292
23	,97759	—	361,09	454,69	6,40	21,99	,2216
22	,97823	—	377,51	471,19	6,32	21,22	,2138
21	,97889	—	395,49	489.25	6,24	20,44	,2059
100 + 20	,97956	—	415,26	509,12	6,14	19,64	,1979
19	,98024	—	437,11	531,08	6,03	18,83	,1897
18	,98095	—	461,40	555,47	5,93	18,00	,1814
17	,98167	—	488,55	582,73	5,82	17,16	,1729
16	,98242	—	519,07	613,39	5,68	16,30	,1643
100 + 15	,98320	—	553,68	648,13	5,55	15,43	,1555
14	,98401	—	593,23	687,82	5.41	14,54	,1465
13	,98485	—	638,87	733,61	5,26	13,63	,1373
12	,98573	—	692,11	787,00	5,11	12,70	,1280
11	,98666	—	755,02	850.09	4.93	11,76	,1185
100 + 10	,98762	—	830,53	925,74	4,79	10,80	,1088
9	,98864	—	922,8	1018,23	4,58	9,82	,0990
8	,98971	—	1038,15	1133,77	4,38	8,82	,0889
7	,99085	—	1186,47	1282,28	4,19	7,80	,0786
6	,99206	—	1384.22	1480,22	4,00	6,76	,0681
100 + 5	,99330	—	1661,05	1757,28	3,77	5,69	,0573
4	,99463	—	2076,31	2172,78	3.53	4,60	,0464
3	,99604	—	2768,43	2865,10	3,33	3,49	,0352
2	,99754	—	4152,58	4249,52	3,06	2,35	,0237
1	,99913	—	8305,28	8402,37	2,91	1,19	,0120

TABLE I. HEAT 48°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,83073	100	—	100,00	—	100,00	1,0069
1	,83303	—	0,83	100,72	0,11	99,28	,9998
2	,83528	—	1,66	101,44	0,22	98,58	,9927
3	,83748	—	2,49	102,17	0,32	97,88	,9857
4	,83962	—	3,32	102,90	0,42	97,19	,9787
100 + 5	,84169	—	4,16	103,63	0,53	96,50	,9717
6	,84373	—	4,98	104,37	0,61	95,81	,9649
7	,84571	—	5,81	105,11	0,70	95,14	,9581
8	,84764	—	6,64	105,85	0,79	94,47	,9514
9	,84952	—	7,47	106,59	0,88	93,81	,9448
100 + 10	,85136	—	8,30	107,34	0,96	93,16	,9381
11	,85316	—	9,13	108,09	1,04	92,52	,9316
12	,85491	—	9,96	108,84	1,12	91,88	,9253
13	,85663	—	10,80	109,59	1,21	91,25	,9189
14	,85830	—	11,62	110,34	1,28	90,63	,9126
100 + 15	,85994	—	12,45	111,09	1,36	90,01	,9064
16	,86155	—	13,28	111,85	1,43	89,40	,9003
17	,86312	—	14,11	112,61	1,50	88,80	,8943
18	,86467	—	14,93	113,37	1,56	88,21	,8883
19	,86620	—	15,76	114,13	1,63	87,62	,8823
100 + 20	,86767	—	16,60	114,89	1,71	87,04	,8764
21	,86916	—	17,43	115,65	1,78	86,47	,8707
22	,87060	—	18,26	116,41	1,85	85,90	,8650
23	,87201	—	19,09	117,17	1,92	85,34	,8593
24	,87339	—	19,92	117,94	1,98	84,79	,8537
100 + 25	,87476	—	20,75	118,71	2,04	84,24	,8482
26	,87609	—	21,58	119,47	2,11	83,70	,8428
27	,87741	—	22,41	120,24	2,17	83,17	,8374
28	,87869	—	23,25	121,02	2,23	82,64	,8321
29	,87996	—	24,07	121,78	2,29	82,11	,8269
100 + 30	,88120	—	24,90	122,55	2,35	81,60	,8216
31	,88243	—	25,73	123,33	2,40	81,09	,8165
32	,88364	—	26,56	124,10	2,46	80,58	,8114
33	,88483	—	27,39	124,87	2,52	80,08	,8064
34	,88600	—	28,22	125,64	2,58	79,59	,8014
100 + 35	,88716	—	29,05	126,41	2,64	79,11	,7965
36	,88828	—	29,88	127,19	2,69	78,63	,7917
37	,88940	—	30,71	127,96	2,75	78,15	,7869
38	,89049	—	31,54	128,74	2,80	77,68	,7821
39	,89157	—	32,37	129,51	2,86	77,21	,7774
100 + 40	,89262	—	33,21	130,29	2,92	76,75	,7728
41	,89368	—	34,04	131,07	2,97	76,30	,7683
42	,89472	—	34,87	131,84	3,03	75,85	,7638
43	,89574	—	35,69	132,62	3,07	75,40	,7593
44	,89675	—	36,52	133,39	3,13	74,96	,7549
100 + 45	,89774	—	37,35	134,17	3,18	74,53	,7505
46	,89872	—	38,18	134,95	3,23	74,10	,7462
47	,89969	—	39,01	135,73	3,28	73,67	,7418
48	,90064	—	39,84	136,51	3,33	73,26	,7376
49	,90157	—	40,67	137,29	3,38	72,84	,7335

I. Spirit and Water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90248	100	41,50	138,07	3,43	72,43	,7293
51	,90338	—	42,33	138,85	3,48	72,02	,7252
52	,90427	—	43,16	139,63	3,53	71,62	,7211
53	,90513	—	43,99	140,42	3,57	71,21	,7171
54	,90599	—	44,82	141,21	3,61	70,82	,7131
100 + 55	,90682	—	45,65	141,98	3,67	70,43	,7091
56	,90765	—	46,48	142,77	3,71	70,04	,7053
57	,90846	—	47,31	143,56	3,75	69,65	,7014
58	,90926	—	48,14	144,35	3,79	69,27	,6976
59	,91004	—	48,97	145,13	3,84	68,90	,6938
100 + 60	,91083	—	49,80	145,92	3,88	68,53	,6900
61	,91159	—	50,64	146,71	3,93	68,16	,6864
62	,91235	—	51,46	147,50	3,96	67,79	,6827
63	,91310	—	52,29	148,29	4,00	67,43	,6790
64	,91383	—	53,12	149,08	4,04	67,07	,6754
100 + 65	,91456	—	53,95	149,87	4,08	66,72	,6719
66	,91528	—	54,78	150,66	4,12	66,37	,6684
67	,91600	—	55,61	151,46	4,15	66,02	,6649
68	,91671	—	56,44	152,24	4,20	65,68	,6614
69	,91740	—	57,27	153,03	4,24	65,35	,6580
100 + 70	,91809	—	58,10	153,82	4,28	65,01	,6546
71	,91876	—	58,93	154,61	4,32	64,68	,6513
72	,91942	—	59,76	155,41	4,35	64,35	,6480
73	,92008	—	60,59	156,20	4,39	64,02	,6447
74	,92072	—	61,42	156,99	4,43	63,70	,6414
100 + 75	,92136	—	62,25	157,78	4,47	63,38	,6382
76	,92199	—	63,08	158,57	4,51	63,06	,6350
77	,92261	—	63,91	159,37	4,54	62,75	,6318
78	,92323	—	64,74	160,17	4,57	62,44	,6287
79	,92382	—	65,57	160,95	4,62	62,13	,6256
100 + 80	,92442	—	66,40	161,75	4,65	61,82	,6225
81	,92502	—	67,23	162,55	4,68	61,52	,6195
82	,92561	—	68,05	163,35	4,70	61,22	,6165
83	,92619	—	68,89	164,14	4,75	60,92	,6135
84	,92676	—	69,72	164,94	4,78	60,63	,6105
100 + 85	,92731	—	70,55	165,73	4,82	60,34	,6076
86	,92789	—	71,38	166,53	4,85	60,05	,6047
87	,92844	—	72,21	167,32	4,89	59,77	,6018
88	,92898	—	73,04	168,12	4,92	59,48	,5990
89	,92952	—	73,87	168,91	4,96	59,20	,5962
100 + 90	,93005	—	74,71	169,71	5,00	58,92	,5933
91	,93056	—	75,54	170,51	5,03	58,65	,5905
92	,93108	—	76,37	171,30	5,07	58,37	,5878
93	,93159	—	77,19	172,10	5,09	58,10	,5851
94	,93210	—	78,02	172,90	5,12	57,84	,5824
100 + 95	,93260	—	78,85	173,70	5,15	57,57	,5797
96	,93308	—	79,67	174,48	5,19	57,31	,5771
97	,93357	—	80,50	175,28	5,22	57,05	,5745
98	,93404	—	81,33	176,08	5,25	56,79	,5719
99	,93451	—	82,16	176,88	5,28	56,53	,5693

TABLE II. **HEAT 48°.**

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93499	100	83,01	177,69	5,32	56,27	,5667
99	,93548	—	83,85	178,50	5,35	56,02	,5641
98	,93595	—	84,71	179,33	5,38	55,76	,5614
97	,93643	—	85,58	180,17	5,41	55,50	,5589
96	,93691	—	86,47	181,03	5,44	55,24	,5563
100 + 95	,93740	—	87,37	181,90	5,47	54,97	,5536
94	,93786	—	88,30	182,80	5,50	54,70	,5509
93	,93834	—	89,25	183,72	5,53	54,43	,5481
92	,93881	—	90,22	184,67	5,55	54,15	,5453
91	,93928	—	91,21	185,63	5,58	53,87	,5425
100 + 90	,93977	—	92,23	186,62	5,61	53,59	,5396
89	,94026	—	93,27	187,61	5,66	53,30	,5367
88	,94076	—	94,33	188,65	5,68	53,01	,5338
87	,94127	—	95,41	189,70	5,71	52,71	,5308
86	,94178	—	96,52	190,78	5,74	52,42	,5278
100 + 85	,94229	—	97,65	191,87	5,78	52,12	,5248
84	,94280	—	98,81	193,01	5,80	51,82	,5217
83	,94333	—	100,01	194,16	5,85	51,51	,5186
82	,94385	—	101,22	195,34	5,88	51,19	,5155
81	,94437	—	102,47	196,56	5,91	50,87	,5123
100 + 80	,94490	—	103,75	197,81	5,94	50,55	,5090
79	,94544	—	105,07	199,09	5,98	50,23	,5058
78	,94597	—	106,42	200,40	6,02	49,90	,5025
77	,94651	—	107,80	201,74	6,06	49,56	,4991
76	,94705	—	109,22	203,14	6,08	49,22	,4957
100 + 75	,94759	—	110,68	204,55	6,13	48,88	,4923
74	,94812	—	112,17	206,02	6,15	48,53	,4888
73	,94867	—	113,70	207,51	6,19	48,18	,4853
72	,94922	—	115,28	209,06	6,22	47,83	,4817
71	,94977	—	116,91	210,66	6,25	47,47	,4780
100 + 70	,95032	—	118,58	212,29	6,29	47,11	,4743
69	,95088	—	120,29	213,97	6,32	46,73	,4706
68	,95144	—	122,06	215,70	6,36	46,36	,4668
67	,95201	—	123,88	217,49	6,39	45,98	,4630
66	,95258	—	125,76	219,33	6,43	45,59	,4591
100 + 65	,95315	—	127,70	221,23	6,47	45,20	,4551
64	,95372	—	129,69	223,19	6,50	44,80	,4511
63	,95429	—	131,75	225,22	6,53	44,40	,4471
62	,95487	—	133,88	227,32	6,56	43,99	,4429
61	,95545	—	136,07	229,48	6,59	43,58	,4388
100 + 60	,95602	—	138,35	231,71	6,64	43,16	,4346
59	,95661	—	140,68	234,02	6,66	42,73	,4303
58	,95720	—	143,11	236,41	6,70	42,30	,4259
57	,95779	—	145,62	238,89	6,73	41,86	,4215
56	,95837	—	148,23	241,47	6,76	41,41	,4170
100 + 55	,95894	—	150,92	244,13	6,79	40,96	,4124
54	,95955	—	153,69	246,89	6,80	40,50	,4079
53	,96013	—	156,58	249,75	6,83	40,03	,4032
52	,96071	—	159,59	252,74	6,85	39,56	,3984
51	,96130	—	162,74	255,86	6,88	39,08	,3936

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96188	100	166,01	259,10	6,91	38,59	,3886
49	,96246	—	169,41	262,46	6,95	38,10	,3836
48	,96304	—	172,93	265 97	6,96	37,60	,3786
47	,96362	—	176,60	269,63	6,97	37,09	,3735
46	,96420	—	180,45	273,46	6,99	36,57	,3683
100 + 45	,96479	—	184,46	277,46	7,00	36,04	,3629
44	,96534	—	188,66	281,63	7,03	35,50	,3575
43	,96591	—	193,04	286,02	7,02	34,96	,3521
42	,96648	—	197,63	290,61	7,02	34,41	,3465
41	,96705	—	202,45	295,43	7,02	33,85	,3408
100 + 40	,96762	—	207,52	300,48	7,04	33,28	,3351
39	,96817	—	212,84	305,80	7,04	32,70	,3293
38	,96873	—	218,43	311,41	7,02	32,11	,3233
37	,96929	—	224,35	317,32	7,03	31,51	,3173
36	,96985	—	230,57	323,57	7,00	30,90	,3112
100 + 35	,97041	—	237,16	330,18	6,98	30,29	,3050
34	,97097	—	244,14	337,18	6,96	29,66	,2987
33	,97154	—	251,53	344,61	6,92	29,02	,2922
32	,97210	—	259,40	352,51	6,89	28,37	,2857
31	,97267	—	267,76	360,91	6,85	27,71	,2790
100 + 30	,97324	—	276,69	369,87	6,82	27,04	,2722
29	,97382	—	286,23	379,47	6,76	26,35	,2653
28	,97440	—	296,45	389,74	6,71	25,66	,2583
27	,97499	—	307,43	400,78	6,65	24,95	,2512
26	,97659	—	319,20	412,68	6,58	24,23	,2440
100 + 25	,97619	—	332,03	425,48	6,55	23,50	,2367
24	,97682	—	345,80	439,38	6,48	22,76	,2292
23	,97745	—	360,90	454,49	6,41	22,00	,2216
22	,97810	—	377,31	470,98	6,33	21,23	,2138
21	,97876	—	395,28	489,03	6,25	20,45	,2059
100 + 20	,97944	—	415,04	508,89	6,15	19 65	,1979
19	,98013	—	436,88	530,84	6 04	18,84	,1897
18	,98084	—	461,15	555,21	5,94	18,01	,1813
17	,98157	—	488,29	582,46	5,83	17,17	,1728
16	,98232	—	518,79	613,10	5,69	16,31	,1642
100 + 15	,98311	—	553,38	647,82	5,56	15,44	,1554
14	,98393	—	592,91	687,49	5,42	14,55	,1464
13	,98477	—	638,53	733,25	5,28	13,64	,1373
12	,98566	—	691,74	786,61	5,13	12,71	,1280
11	,98660	—	754,62	849,66	4,96	11,77	,1185
100 + 10	,98756	—	830,08	925,27	4,81	10,80	,1088
9	,98858	—	922,32	1017,70	4,62	9,82	,0990
8	,98966	—	1037,60	1133,18	4,42	8,82	,0889
7	,99080	—	1185,84	1281,61	4,23	7,80	,0786
6	,99201	—	1383,48	1479,44	4,04	6,76	,0681
100 + 5	,99326	—	1660,17	1756,36	3,81	5,69	,0573
4	,99459	—	2075,71	2171,63	3,58	4,61	,0464
3	,99600	—	2766,95	2863,58	3,37	3,49	,0352
2	,99750	—	4150,38	4247,26	3,12	2,36	,0237
1	,99909	—	8300,85	8397,88	2,97	1,19	,0120

TABLE I. HEAT 49°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.								Sp. + W.							
100 + 0	,83025	100	—	100,00	—	100,00	1,0064	100 + 50	,90204	100	41,48	138,06	3,42	72,43	,7289
1	,83256	—	0,83	100,72	0,11	99,28	,9992	51	,90294	—	42,31	138,84	3,47	72,02	,7248
2	,83481	—	1,66	101,44	0,22	98,58	,9921	52	,90383	—	43,14	139,62	3,52	71,62	,7207
3	,83701	—	2,49	102,17	0,32	97,88	,9851	53	,90470	—	43,97	140,41	3,56	71,22	,7167
4	,83915	—	3,32	102,90	0,42	97,19	,9781	54	,90556	—	44,80	141,19	3,61	70,82	,7127
100 + 5	,84122	—	4,16	103,63	0,53	96,50	,9711	100 + 55	,90639	—	45,63	141,97	3,66	70,43	,7088
6	,84326	—	4,98	104,37	0,61	95,81	,9643	56	,90722	—	46,46	142,76	3,70	70,04	,7050
7	,84524	—	5,81	105,11	0,70	95,14	,9576	57	,90803	—	47,28	143,55	3,73	69,66	,7011
8	,84717	—	6,64	105,84	0,80	94,48	,9509	58	,90883	—	48,12	144,34	3,78	69,28	,6973
9	,84905	—	7,47	106,59	0,88	93,82	,9443	59	,90962	—	48,94	145,12	3,82	68,90	,6935
100 + 10	,85089	—	8,30	107,33	0,97	93,17	,9376	100 + 60	,91040	—	49,77	145,91	3,86	68,53	,6897
11	,85269	—	9,13	108,08	1,05	92,53	,9311	61	,91116	—	50,61	146,70	3,91	68,17	,6861
12	,85444	—	9,96	108,83	1,13	91,89	,9247	62	,91192	—	51,43	147,49	3,94	67,80	,6824
13	,85616	—	10,79	109,58	1,21	91,26	,9184	63	,91267	—	52,26	148,28	3,98	67,44	,6787
14	,85784	—	11,62	110,34	1,28	90,63	,9121	64	,91340	—	53,09	149,07	4,02	67,08	,6751
100 + 15	,85948	—	12,45	111,09	1,36	90,02	,9059	100 + 65	,91413	—	53,92	149,86	4,06	66,73	,6715
16	,86109	—	13,28	111,85	1,43	89,41	,8998	66	,91485	—	54,75	150,65	4,10	66,38	,6681
17	,86266	—	14,10	112,60	1,50	88,80	,8938	67	,91557	—	55,58	151,44	4,14	66,03	,6646
18	,86421	—	14,93	113,36	1,57	88,21	,8878	68	,91628	—	56,41	152,23	4,18	65,69	,6611
19	,86574	—	15,75	114,12	1,63	87,62	,8819	69	,91697	—	57,24	153,01	4,23	65,35	,6577
100 + 20	,86721	—	16,59	114,89	1,70	87,04	,8760	100 + 70	,91766	—	58,07	153,81	4,26	65,02	,6543
21	,86870	—	17,42	115,64	1,78	86,47	,8702	71	,91833	—	58,90	154,60	4,30	64,69	,6510
22	,87014	—	18,25	116,41	1,84	85,90	,8645	72	,91899	—	59,73	155,39	4,34	64,36	,6477
23	,87155	—	19,08	117,17	1,91	85,34	,8589	73	,91965	—	60,56	156,19	4,37	64,03	,6444
24	,87293	—	19,91	117,94	1,97	84,79	,8533	74	,92029	—	61,39	156,97	4,42	63,70	,6411
100 + 25	,87430	—	20,74	118,70	2,04	84,25	,8478	100 + 75	,92094	—	62,22	157,77	4,45	63,38	,6379
26	,87564	—	21,57	119,47	2,10	83,71	,8423	76	,92156	—	63,05	158,55	4,50	63,06	,6347
27	,87695	—	22,40	120,24	2,16	83,17	,8369	77	,92218	—	63,88	159,35	4,53	62,75	,6315
28	,87824	—	23,24	121,01	2,23	82,64	,8317	78	,92280	—	64,71	160,15	4,56	62,44	,6284
29	,87951	—	24,06	121,78	2,28	82,12	,8265	79	,92340	—	65,54	160,93	4,61	62,14	,6253
100 + 30	,88075	—	24,89	122,55	2,34	81,60	,8212	100 + 80	,92400	—	66,37	161,73	4,64	61,83	,6222
31	,88198	—	25,71	123,32	2,39	81,09	,8161	81	,92459	—	67,19	162,53	4,66	61,53	,6192
32	,88319	—	26,54	124,09	2,45	80,59	,8110	82	,92518	—	68,02	163,33	4,69	61,23	,6162
33	,88438	—	27,37	124,86	2,51	80,09	,8060	83	,92577	—	68,85	164,12	4,73	60,93	,6132
34	,88555	—	28,21	125,63	2,58	79,60	,8010	84	,92633	—	69,68	164,92	4,76	60,63	,6102
100 + 35	,88671	—	29,03	126,40	2,63	79,11	,7961	100 + 85	,92689	—	70,51	165,71	4,80	60,34	,6073
36	,88784	—	29,87	127,18	2,69	78,63	,7913	86	,92746	—	71,34	166,51	4,83	60,05	,6044
37	,88895	—	30,70	127,95	2,75	78,15	,7865	87	,92801	—	72,17	167,30	4,87	59,77	,6015
38	,89004	—	31,53	128,73	2,80	77,68	,7817	88	,92855	—	73,00	168,10	4,90	59,49	,5987
39	,89113	—	32,36	129,50	2,86	77,21	,7770	89	,92909	—	73,83	168,89	4,94	59,21	,5959
100 + 40	,89218	—	33,19	130,28	2,91	76,75	,7724	100 + 90	,92962	—	74,67	169,69	4,98	58,93	,5930
41	,89324	—	34,02	131,06	2,96	76,30	,7679	91	,93014	—	75,50	170,49	5,01	58,65	,5902
42	,89427	—	34,85	131,83	3,02	75,85	,7634	92	,93066	—	76,33	171,28	5,05	58,38	,5875
43	,89530	—	35,67	132,61	3,06	75,41	,7589	93	,93118	—	77,15	172,08	5,07	58,11	,5848
44	,89630	—	36,50	133,39	3,11	74,97	,7545	94	,93169	—	77,98	172,87	5,11	57,84	,5821
100 + 45	,89729	—	37,33	134,17	3,16	74,53	,7501	100 + 95	,93219	—	78,81	173,68	5,13	57,58	,5794
46	,89827	—	38,16	134,94	3,22	74,10	,7458	96	,93267	—	79,63	174,46	5,17	57,32	,5768
47	,89924	—	38,99	135,72	3,27	73,68	,7415	97	,93316	—	80,46	175,26	5,20	57,06	,5742
48	,90019	—	39,82	136,50	3,32	73,26	,7373	98	,93364	—	81,29	176,05	5,24	56,80	,5716
49	,90113	—	40,65	137,28	3,37	72,84	,7331	99	,93411	—	82,12	176,86	5,26	56,54	,5690

TABLE II. HEAT 49°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100+100	,93459	100	82,96	177,67	5,29	56,28	,5664	100 + 50	,96157	100	165,92	259,03	6,89	38,60	,3885
99	,93507	—	83,81	178,48	5,33	56,02	,5638	49	,96216	—	169,32	262,39	6,93	38,11	,3835
98	,93555	—	84,67	179,31	5,36	55,76	,5612	48	,96274	—	172,84	265,90	6,94	37,61	,3785
97	,93602	—	85,54	180,15	5,39	55,50	,5586	47	,96333	—	176,51	269,56	6,95	37,10	,3734
96	,93651	—	86,44	181,01	5,43	55,24	,5560	46	,96391	—	180,35	273,38	6,97	36,58	,3681
100 + 95	,93699	—	87,32	181,88	5,44	54,98	,5533	100 + 45	,96451	—	184,36	277,38	6,98	36,05	,3628
94	,93746	—	88,25	182,78	5,47	54,71	,5506	44	,96506	—	188,56	281,55	7,01	35,51	,3574
93	,93794	—	89,20	183,70	5,50	54,44	,5478	43	,96564	—	192,94	285,94	7,00	34,97	,3520
92	,93841	—	90,17	184,65	5,52	54,16	,5450	42	,96621	—	197,53	290,53	7,00	34,42	,3464
91	,93888	—	91,16	185,61	5,55	53,88	,5422	41	,96678	—	202,34	295,34	7,00	33,86	,3407
100 + 90	,93937	—	92,18	186,59	5,59	53,59	,5393	100. + 40	,96736	—	207,41	300,39	7,02	33,29	,3350
89	,93986	—	93,22	187,59	5,63	53,30	,5365	39	,96791	—	212,73	305,71	7,02	32,71	,3292
88	,94036	—	94,28	188,62	5,66	53,01	,5336	38	,96848	—	218,32	311,32	7,00	32,12	,3233
87	,94087	—	95,36	189,67	5,69	52,72	,5306	37	,96905	—	224,23	317,22	7,01	31,52	,3172
86	,94138	—	96,47	190,75	5,72	52,42	,5276	36	,96962	—	230,45	323,46	6,99	30,91	,3111
100 + 85	,94189	—	97,60	191,85	5,75	52,12	,5245	100 + 35	,97018	—	237,03	330,06	6,97	30,30	,3049
84	,94241	—	98,76	192,98	5,78	51,82	,5215	34	,97075	—	244,01	337,06	6,95	29,67	,2986
83	,94294	—	99,95	194,13	5,82	51,51	,5184	33	,97132	—	251,40	344,48	6,92	29,03	,2922
82	,94346	—	101,17	195,31	5,86	51,20	,5153	32	,97189	—	259,26	352,38	6,88	28,38	,2857
81	,94399	—	102,42	196,53	5,89	50,88	,5121	31	,97246	—	267,62	360,77	6,85	27,72	,2790
100 + 80	,94452	—	103,70	197,78	5,92	50,56	,5088	100 + 30	,97304	—	276,54	369,73	6,81	27,05	,2722
79	,94506	—	105,02	199,05	5,97	50,24	,5056	29	,97363	—	286,08	379,32	6,76	26,36	,2653
78	,94559	—	106,36	200,36	6,00	49,91	,5023	28	,97422	—	296,29	389,59	6,70	25,67	,2583
77	,94613	—	107,74	201,71	6,03	49,57	,4989	27	,97482	—	307,27	400,62	6,65	24,96	,2512
76	,94667	—	109,16	203,10	6,06	49,23	,4955	26	,97643	—	319,09	412,51	6,58	24,24	,2439
100 + 75	,94721	—	110,62	204,52	6,10	48,89	,4921	100 + 25	,97604	—	331,85	425,31	6,54	23,51	,2366
74	,94775	—	112,11	205,98	6,13	48,54	,4886	24	,97667	—	345,68	439,20	6,48	22,77	,2292
73	,94830	—	113,64	207,48	6,16	48,19	,4851	23	,97731	—	360,71	454,30	6,41	22,01	,2215
72	,94885	—	115,22	209,02	6,20	47,84	,4815	22	,97797	—	377,11	470,78	6,33	21,24	,2137
71	,94940	—	116,85	210,62	6,23	47,48	,4778	21	,97864	—	395,07	488,82	6,25	20,46	,2058
100 + 70	,94995	—	118,52	212,25	6,27	47,11	,4741	100 + 20	,97932	—	414,82	508,66	6,16	19,66	,1978
69	,95051	—	120,23	213,93	6,30	46,74	,4704	19	,98002	—	436,65	530,60	6,05	18,85	,1896
68	,95108	—	122,00	215,66	6,34	46,37	,4666	18	,98073	—	460,91	554,96	5,95	18,02	,1813
67	,95165	—	123,82	217,45	6,37	45,99	,4628	17	,98147	—	488,03	582,19	5,84	17,18	,1728
66	,95222	—	125,70	219,29	6,41	45,60	,4589	16	,98223	—	518,52	612,81	5,71	16,32	,1642
100 + 65	,95279	—	127,63	221,19	6,44	45,21	,4550	100 + 15	,98302	—	553,09	647,51	5,58	15,44	,1554
64	,95336	—	129,62	223,15	6,47	44,81	,4510	14	,98385	—	592,60	687,16	5,44	14,55	,1464
63	,95394	—	131,68	225,17	6,51	44,41	,4469	13	,98470	—	638,19	732,89	5,30	13,64	,1373
62	,95452	—	133,81	227,26	6,55	44,00	,4428	12	,98559	—	691,37	786,22	5,15	12,72	,1280
61	,95510	—	136,00	229,43	6,57	43,59	,4386	11	,98654	—	754,22	849,23	4,99	11,78	,1185
100 + 60	,95568	—	138,27	231,66	6,61	43,17	,4344	100 + 10	,98750	—	829,64	924,80	4,84	10,81	,1088
59	,95627	—	140,60	233,97	6,63	42,74	,4301	9	,98853	—	921,83	1017,18	4,65	9,83	,0989
58	,95687	—	143,04	236,36	6,68	42,31	,4258	8	,98961	—	1037,05	1132,60	4,45	8,83	,0888
57	,95746	—	145,54	238,83	6,71	41,87	,4214	7	,99075	—	1185,21	1280,94	4,27	7,81	,0786
56	,95804	—	148,15	241,41	6,74	41,42	,4169	6	,99196	—	1382,74	1478,67	4,07	6,76	,0681
100 + 55	,95862	—	150,84	244,07	6,77	40,97	,4123	100 + 5	,99321	—	1659,29	1755,44	3,85	5,70	,0573
54	,95923	—	153,61	246,83	6,78	40,51	,4078	4	,99454	—	2074,11	2170,49	3,62	4,61	,0464
53	,95981	—	156,50	249,69	6,81	40,04	,4031	3	,99596	—	2765,48	2862,07	3,41	3,49	,0352
52	,96040	—	159,51	252,68	6,83	39,57	,3983	2	,99746	—	4148,20	4245,02	3,18	2,36	,0237
51	,96099	—	162,65	255,80	6,85	39,09	,3935	1	,99905	—	8296,45	8393,42	3,03	1,19	,0120

TABLE I. HEAT 50°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82977	100	—	100,00	—	100,00	1,0058
1	,83208	—	0,83	100,72	0,11	99,29	,9986
2	,83434	—	1,66	101,44	0,22	98,58	,9915
3	,83654	—	2,49	102,16	0,33	97,88	,9845
4	,83868	—	3,32	102,89	0,43	97,19	,9776
100 + 5	,84076	—	4,15	103,63	0,52	96,50	,9706
6	,84279	—	4,97	104,36	0,61	95,82	,9637
7	,84477	—	5,80	105,10	0,70	95,15	,9570
8	,84670	—	6,63	105,84	0,79	94,48	,9503
9	,84858	—	7,46	106,58	0,88	93,82	,9437
100 + 10	,85042	—	8,29	107,33	0,96	93,17	,9371
11	,85222	—	9,12	108,08	1,04	92,53	,9306
12	,85397	—	9,95	108,83	1,12	91,89	,9242
13	,85569	—	10,78	109,58	1,20	91,26	,9179
14	,85738	—	11,61	110,33	1,28	90,64	,9116
100 + 15	,85902	—	12,44	111,08	1,36	90,02	,9054
16	,86063	—	13,27	111,84	1,43	89,41	,8993
17	,86220	—	14,09	112,60	1,49	88,81	,8933
18	,86375	—	14,92	113,36	1,56	88,22	,8873
19	,86527	—	15,75	114,12	1,63	87,63	,8814
100 + 20	,86676	—	16,58	114,88	1,70	87,05	,8755
21	,86823	—	17,41	115,64	1,77	86,48	,8697
22	,86967	—	18,24	116,40	1,84	85,91	,8640
23	,87108	—	19,07	117,16	1,91	85,35	,8584
24	,87247	—	19,90	117,93	1,97	84,80	,8529
100 + 25	,87384	—	20,73	118,70	2,03	84,25	,8474
26	,87518	—	21,56	119,46	2,10	83,71	,8419
27	,87649	—	22,39	120,23	2,16	83,18	,8365
28	,87778	—	23,22	121,00	2,22	82,65	,8312
29	,87905	—	24,05	121,77	2,28	82,12	,8260
100 + 30	,88030	—	24,88	122,54	2,34	81,61	,8208
31	,88153	—	25,70	123,31	2,39	81,10	,8157
32	,88274	—	26,53	124,08	2,45	80,59	,8106
33	,88393	—	27,36	124,85	2,51	80,09	,8056
34	,88510	—	28,19	125,62	2,57	79,60	,8006
100 + 35	,88626	—	29,02	126,40	2,62	79,12	,7957
36	,88739	—	29,85	127,17	2,68	78,64	,7909
37	,88850	—	30,68	127,94	2,74	78,16	,7861
38	,88960	—	31,51	128,72	2,79	77,69	,7814
39	,89068	—	32,34	129,49	2,85	77,22	,7767
100 + 40	,89174	—	33,17	130,27	2,90	76,76	,7721
41	,89279	—	34,00	131,05	2,95	76,31	,7675
42	,89382	—	34,83	131,82	3,01	75,86	,7630
43	,89484	—	35,65	132,60	3,05	75,41	,7585
44	,89585	—	36,48	133,38	3,10	74,97	,7541
100 + 45	,89684	—	37,31	134,16	3,15	74,54	,7497
46	,89782	—	38,14	134,93	3,21	74,11	,7454
47	,89879	—	38,97	135,71	3,26	73,69	,7411
48	,89974	—	39,80	136,49	3,31	73,27	,7369
49	,90068	—	40,63	137,27	3,36	72,85	,7327

I. Spirit and water by weight.	II. Specific gravity	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90160	100	41,46	138,05	3,41	72,44	,7286
51	,90250	—	42,29	138,83	3,46	72,03	,7245
52	,90339	—	43,12	139,61	3,51	71,63	,7204
53	,90426	—	43,95	140,40	3,55	71,23	,7164
54	,90512	—	44,78	141,18	3,60	70,83	,7124
100 + 55	,90596	—	45,61	141,96	3,65	70,44	,7085
56	,90679	—	46,43	142,75	3,68	70,05	,7046
57	,90760	—	47,26	143,54	3,72	69,67	,7007
58	,90840	—	48,09	144,33	3,76	69,29	,6969
59	,90919	—	48,92	145,11	3,81	68,91	,6931
100 + 60	,90997	—	49,75	145,90	3,85	68,54	,6894
61	,91073	—	50,58	146,69	3,89	68,17	,6857
62	,91149	—	51,41	147,48	3,93	67,81	,6820
63	,91224	—	52,24	148,26	3,98	67,45	,6784
64	,91297	—	53,07	149,06	4,01	67,09	,6748
100 + 65	,91370	—	53,90	149,85	4,05	66,74	,6712
66	,91442	—	54,73	150,64	4,09	66,39	,6677
67	,91514	—	55,56	151,42	4,14	66,04	,6642
68	,91585	—	56,38	152,21	4,17	65,70	,6608
69	,91654	—	57,21	153,00	4,21	65,36	,6574
100 + 70	,91723	—	58,04	153,79	4,25	65,02	,6540
71	,91790	—	58,87	154,58	4,29	64,69	,6507
72	,91856	—	59,70	155,37	4,33	64,36	,6474
73	,91922	—	60,53	156,17	4,36	64,03	,6441
74	,91986	—	61,36	156,96	4,40	63,71	,6408
100 + 75	,92051	—	62,19	157,75	4,44	63,39	,6376
76	,92113	—	63,02	158,54	4,48	63,07	,6344
77	,92175	—	63,85	159,33	4,52	62,76	,6312
78	,92237	—	64,68	160,13	4,55	62,45	,6281
79	,92298	—	65,51	160,92	4,59	62,14	,6250
100 + 80	,92358	—	66,34	161,72	4,62	61,84	,6219
81	,92417	—	67,16	162,51	4,65	61,53	,6189
82	,92476	—	67,99	163,31	4,68	61,23	,6159
83	,92534	—	68,82	164,10	4,72	60,94	,6129
84	,92591	—	69,65	164,90	4,75	60,64	,6099
100 + 85	,92647	—	70,48	165,69	4,79	60,35	,6070
86	,92703	—	71,31	166,49	4,82	60,06	,6041
87	,92758	—	72,14	167,28	4,86	59,78	,6012
88	,92812	—	72,97	168,08	4,89	59,50	,5984
89	,92866	—	73,80	168,87	4,93	59,22	,5956
100 + 90	,92919	—	74,63	169,67	4,96	58,94	,5928
91	,92972	—	75,46	170,47	4,99	58,66	,5900
92	,93024	—	76,29	171,26	5,03	58,39	,5872
93	,93076	—	77,11	172,06	5,05	58,12	,5845
94	,93127	—	77,94	172,85	5,09	57,85	,5818
100 + 95	,93177	—	78,77	173,65	5,12	57,59	,5792
96	,93226	—	79,59	174,44	5,15	57,33	,5766
97	,93275	—	80,42	175,23	5,19	57,07	,5740
98	,93323	—	81,25	176,03	5,22	56,81	,5714
99	,93371	—	82,08	176,83	5,25	56,55	,5688

TABLE II. HEAT 50°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,93419	100	82,92	177,64	5,28	56,29	,5662	100 + 50	,96126	100	165,84	258,96	6,88	38,61	,3884
99	,93467	—	83,76	178,46	5,30	56,03	,5636	49	,96185	—	169,23	262,32	6,91	38,12	,3834
98	,93515	—	84,62	179,29	5,33	55,77	,5610	48	,96244	—	172,75	265,83	6,92	37,62	,3783
97	,93562	—	85,50	180,13	5,37	55,51	,5584	47	,96303	—	176,42	269,49	6,93	37,11	,3732
96	,93610	—	86,38	180,98	5,40	55,25	,5558	46	,96361	—	180,26	273,31	6,95	36,59	,3680
100 + 95	,93658	—	87,28	181,85	5,43	54,99	,5531	100 + 45	,96420	—	184,27	277,30	6,97	36,06	,3627
94	,93705	—	88,21	182,75	5,46	54,72	,5504	44	,96478	—	188,46	281,48	6,98	35,52	,3573
93	,93753	—	89,16	183,67	5,49	54,44	,5476	43	,96536	—	192,84	285,86	6,98	34,98	,3518
92	,93801	—	90,13	184,62	5,51	54,17	,5448	42	,96593	—	197,43	290,45	6,98	34,43	,3463
91	,93848	—	91,12	185,58	5,54	53,89	,5420	41	,96651	—	202,24	295,26	6,98	33,87	,3406
100 + 90	,93897	—	92,13	186,56	5,57	53,60	,5391	100 + 40	,96708	—	207,30	300,31	6,99	33,30	,3349
89	,93946	—	93,17	187,56	5,61	53,31	,5362	39	,96765	—	212,62	305,62	7,00	32,72	,3291
88	,93996	—	94,23	188,59	5,64	53,02	,5333	38	,96823	—	218,21	311,22	6,99	32,13	,3232
87	,94047	—	95,31	189,64	5,67	52,73	,5303	37	,96880	—	224,11	317,12	6,99	31,53	,3171
86	,94098	—	96,42	190,72	5,70	52,43	,5273	36	,96938	—	230,33	323,35	6,98	30,92	,3110
100 + 85	,94149	—	97,55	191,82	5,73	52,13	,5243	100 + 35	,96995	—	236,91	329,95	6,96	30,31	,3048
84	,94201	—	98,71	192,95	5,76	51,83	,5213	34	,97052	—	243,88	336,94	6,94	29,68	,2985
83	,94254	—	99,90	194,10	5,80	51,52	,5182	33	,97110	—	251,27	344,36	6,91	29,04	,2921
82	,94307	—	101,12	195,28	5,84	51,21	,5150	32	,97167	—	259,13	352,25	6,88	28,39	,2856
81	,94360	—	102,37	196,50	5,87	50,89	,5118	31	,97225	—	267,48	360,64	6,84	27,73	,2789
100 + 80	,94414	—	103,65	197,74	5,91	50,57	,5086	100 + 30	,97284	—	276,40	369,60	6,80	27,06	,2721
79	,94467	—	104,96	199,02	5,94	50,25	,5054	29	,97343	—	285,93	379,18	6,75	26,37	,2652
78	,94521	—	106,31	200,33	5,98	49,92	,5021	28	,97403	—	296,14	389,44	6,70	25,68	,2582
77	,94575	—	107,69	201,68	6,01	49,58	,4988	27	,97464	—	307,11	400,46	6,65	24,97	,2511
76	,94629	—	109,11	203,06	6,05	49,24	,4954	26	,97526	—	318,92	412,34	6,58	24,25	,2439
100 + 75	,94683	—	110,56	204,48	6,08	48,90	,4919	100 + 25	,97589	—	331,68	425,14	6,54	23,52	,2366
74	,94737	—	112,05	205,94	6,11	48,55	,4884	24	,97652	—	345,50	439,02	6,48	22,78	,2291
73	,94792	—	113,58	207,44	6,14	48,20	,4849	23	,97717	—	360,52	454,11	6,41	22,02	,2215
72	,94847	—	115,16	208,99	6,17	47,85	,4813	22	,97783	—	376,91	470,58	6,33	21,25	,2137
71	,94902	—	116,79	210,58	6,21	47,49	,4776	21	,97851	—	394,86	488,61	6,25	20,46	,2058
100 + 70	,94958	—	118,46	212,21	6,25	47,12	,4739	100 + 20	,97920	—	414,60	508,44	6,16	19,67	,1978
69	,95014	—	120,17	213,89	6,28	46,75	,4702	19	,97990	—	436,42	530,36	6,06	18,86	,1896
68	,95071	—	121,94	215,62	6,32	46,38	,4664	18	,98062	—	460,67	554,71	5,96	18,03	,1813
67	,95128	—	123,76	217,41	6,35	46,00	,4626	17	,98136	—	487,77	581,92	5,85	17,18	,1728
66	,95185	—	125,64	219,25	6,39	45,61	,4587	16	,98213	—	518,25	612,53	5,72	16,32	,1642
100 + 65	,95243	—	127,57	221,15	6,42	45,22	,4548	100 + 15	,98293	—	552,80	647,20	5,60	15,45	,1554
64	,95300	—	129,56	223,11	6,45	44,82	,4508	14	,98376	—	592,29	686,83	5,46	14,56	,1464
63	,95358	—	131,61	225,13	6,48	44,42	,4467	13	,98462	—	637,85	732,53	5,32	13,65	,1373
62	,95416	—	133,74	227,22	6,52	44,01	,4426	12	,98552	—	691,00	785,83	5,17	12,72	,1280
61	,95475	—	135,93	229,38	6,55	43,60	,4384	11	,98647	—	753,82	848,80	5,02	11,78	,1185
100 + 60	,95534	—	138,20	231,61	6,59	43,18	,4342	100 + 10	,98745	—	829,20	924,33	4,87	10,82	,1088
59	,95593	—	140,53	233,92	6,61	42,75	,4299	9	,98847	—	921,34	1016,66	4,68	9,84	,0989
58	,95653	—	142,96	236,30	6,66	42,32	,4256	8	,98955	—	1036,50	1132,02	4,48	8,83	,0888
57	,95712	—	145,47	238,78	6,69	41,88	,4212	7	,99070	—	1184,58	1280,28	4,30	7,81	,0786
56	,95771	—	148,07	241,35	6,72	41,43	,4167	6	,99190	—	1382,00	1477,90	4,10	6,77	,0681
100 + 55	,95831	—	150,76	244,01	6,75	40,98	,4122	100 + 5	,99316	—	1658,41	1754,52	3,89	5,70	,0573
54	,95890	—	153,53	246,77	6,76	40,52	,4076	4	,99449	—	2073,01	2169,35	3,66	4,61	,0464
53	,95949	—	156,42	249,63	6,79	40,05	,4029	3	,99591	—	2764,02	2860,57	3,45	3,50	,0352
52	,96008	—	159,43	252,62	6,81	39,58	,3981	2	,99742	—	4146,03	4242,79	3,24	2,36	,0237
51	,96067	—	162,57	255,73	6,84	39,10	,3933	1	,99901	—	8292,06	8388,98	3,08	1,19	,0120

TABLE I. HEAT 51°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82929	100	—	100,00	—	100,00	1,0052
1	,83160	—	0,83	100,72	0,11	99,29	,9981
2	,83386	—	1,66	101,44	0,22	98,58	,9910
3	,83606	—	2,49	102,16	0,33	97,88	,9840
4	,83820	—	3,32	102,89	0,43	97,19	,9770
100 + 5	,84028	—	4,15	103,63	0,52	96,50	,9700
6	,84231	—	4,97	104,36	0,61	95,82	,9632
7	,84429	—	5,80	105,10	0,70	95,15	,9565
8	,84622	—	6,63	105,84	0,79	94,48	,9498
9	,84810	—	7,46	106,58	0,88	93,82	,9432
100 + 10	,84994	—	8,29	107,33	0,96	93,17	,9366
11	,85174	—	9,12	108,08	1,04	92,53	,9301
12	,85350	—	9,94	108,83	1,11	91,89	,9237
13	,85522	—	10,78	109,58	1,20	91,26	,9174
14	,85691	—	11,60	110,33	1,27	90,64	,9111
100 + 15	,85855	—	12,43	111,08	1,35	90,02	,9049
16	,86016	—	13,26	111,84	1,42	89,41	,8988
17	,86173	—	14,09	112,59	1,50	88,81	,8928
18	,86328	—	14,92	113,35	1,57	88,22	,8868
19	,86480	—	15,74	114,11	1,63	87,63	,8809
100 + 20	,86629	—	16,57	114,88	1,69	87,05	,8750
21	,86776	—	17,40	115,64	1,76	86,48	,8692
22	,86920	—	18,23	116,40	1,83	85,91	,8635
23	,87062	—	19,06	117,16	1,90	85,35	,8579
24	,87201	—	19,89	117,93	1,96	84,80	,8524
100 + 25	,87337	—	20,72	118,69	2,03	84,25	,8469
26	,87472	—	21,55	119,46	2,09	83,71	,8415
27	,87603	—	22,38	120,23	2,15	83,18	,8361
28	,87732	—	23,21	120,99	2,22	82,65	,8308
29	,87859	—	24,04	121,76	2,28	82,13	,8256
100 + 30	,87984	—	24,87	122,54	2,33	81,61	,8204
31	,88107	—	25,69	123,30	2,39	81,10	,8153
32	,88228	—	26,51	124,07	2,44	80,60	,8102
33	,88347	—	27,35	124,84	2,51	80,10	,8052
34	,88464	—	28,18	125,62	2,56	79,61	,8002
100 + 35	,88580	—	29,01	126,39	2,62	79,12	,7953
36	,88693	—	29,83	127,16	2,67	78,64	,7905
37	,88804	—	30,66	127,93	2,73	78,16	,7857
38	,88914	—	31,49	128,71	2,78	77,69	,7810
39	,89022	—	32,32	129,48	2,84	77,22	,7763
100 + 40	,89128	—	33,15	130,26	2,89	76,76	,7717
41	,89234	—	33,98	131,04	2,94	76,31	,7671
42	,89337	—	34,81	131,81	3,00	75,86	,7626
43	,89439	—	35,63	132,59	3,04	75,42	,7582
44	,89540	—	36,46	133,37	3,09	74,98	,7538
100 + 45	,89638	—	37,29	134,15	3,14	74,54	,7494
46	,89737	—	38,12	134,92	3,20	74,11	,7450
47	,89834	—	38,95	135,70	3,25	73,69	,7408
48	,89929	—	39,78	136,48	3,30	73,27	,7366
49	,90023	—	40,60	137,26	3,34	72,85	,7324

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90115	100	41,44	138,04	3,40	72,44	,7282
51	,90205	—	42,27	138,82	3,45	72,03	,7241
52	,90294	—	43,09	139,60	3,49	71,63	,7201
53	,90381	—	43,92	140,38	3,54	71,23	,7161
54	,90467	—	44,75	141,17	3,58	70,84	,7121
100 + 55	,90551	—	45,58	141,95	3,63	70,45	,7081
56	,90634	—	46,40	142,74	3,66	70,06	,7042
57	,90715	—	47,23	143,52	3,71	69,67	,7004
58	,90795	—	48,06	144,31	3,75	69,29	,6966
59	,90874	—	48,89	145,09	3,80	68,92	,6928
100 + 60	,90952	—	49,72	145,88	3,84	68,55	,6890
61	,91028	—	50,55	146,67	3,88	68,18	,6853
62	,91104	—	51,38	147,46	3,92	67,81	,6817
63	,91179	—	52,21	148,24	3,97	67,45	,6781
64	,91252	—	53,04	149,04	4,00	67,09	,6745
100 + 65	,91324	—	53,87	149,83	4,04	66,74	,6709
66	,91397	—	54,70	150,62	4,08	66,39	,6674
67	,91469	—	55,53	151,40	4,13	66,04	,6639
68	,91541	—	56,35	152,19	4,16	65,70	,6605
69	,91610	—	57,18	152,98	4,20	65,36	,6571
100 + 70	,91679	—	58,01	153,77	4,24	65,03	,6537
71	,91747	—	58,84	154,56	4,28	64,70	,6504
72	,91813	—	59,67	155,35	4,32	64,37	,6471
73	,91879	—	60,49	156,15	4,34	64,04	,6438
74	,91944	—	61,32	156,94	4,38	63,72	,6405
100 + 75	,92009	—	62,15	157,73	4,42	63,40	,6373
76	,92070	—	62,98	158,52	4,46	63,08	,6341
77	,92133	—	63,81	159,31	4,50	62,77	,6309
78	,92195	—	64,64	160,11	4,53	62,46	,6278
79	,92256	—	65,48	160,90	4,58	62,15	,6247
100 + 80	,92316	—	66,30	161,70	4,60	61,84	,6217
81	,92375	—	67,12	162,49	4,63	61,54	,6187
82	,92434	—	67,95	163,29	4,66	61,24	,6157
83	,92492	—	68,78	164,08	4,70	60,94	,6127
84	,92549	—	69,61	164,88	4,73	60,65	,6097
100 + 85	,92604	—	70,44	165,67	4,77	60,36	,6067
86	,92661	—	71,27	166,47	4,80	60,07	,6038
87	,92716	—	72,10	167,26	4,84	59,79	,6010
88	,92770	—	72,93	168,06	4,87	59,50	,5982
89	,92824	—	73,76	168,85	4,91	59,22	,5954
100 + 90	,92877	—	74,59	169,64	4,95	58,95	,5925
91	,92930	—	75,42	170,44	4,98	58,67	,5898
92	,92982	—	76,25	171,24	5,01	58,40	,5870
93	,93034	—	77,07	172,04	5,03	58,13	,5843
94	,93085	—	77,90	172,83	5,07	57,86	,5816
100 + 95	,93135	—	78,73	173,63	5,10	57,59	,5789
96	,93184	—	79,55	174,42	5,13	57,33	,5763
97	,93233	—	80,37	175,21	5,16	57,07	,5737
98	,93281	—	81,20	176,00	5,20	56,81	,5711
99	,93329	—	82,03	176,80	5,23	56,56	,5685

TABLE II. HEAT 51°.

I. Water and Spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,93377	100	82,87	177,61	5,26	56,30	,5659	100 + 50	,96094	100	165,75	258,89	6,86	38,62	,3883
99	,93425	—	83,71	178,43	5,28	56,04	,5633	49	,96154	—	169,14	262,26	6,88	38,13	,3833
98	,93474	—	84,57	179,27	5,30	55,78	,5607	48	,96213	—	172,66	265,76	6,90	37,63	,3782
97	,93521	—	85,45	180,10	5,35	55,52	,5581	47	,96273	—	176,32	269,41	6,91	37,12	,3731
96	,93569	—	86,33	180,95	5,38	55,26	,5555	46	,96331	—	180,16	273,23	6,93	36,60	,3679
100 + 95	,93616	—	87,23	181,83	5,40	54,99	,5528	100 + 45	,96391	—	184,17	277,23	6,94	36,07	,3626
94	,93664	—	88,16	182,73	5,43	54,72	,5502	44	,96449	—	188,36	281,40	6,96	35,53	,3572
93	,93713	—	89,11	183,64	5,47	54,45	,5474	43	,96508	—	192,73	285,77	6,96	34,99	,3517
92	,93761	—	90,08	184,59	5,49	54,18	,5446	42	,96566	—	197,32	290,37	6,95	34,44	,3462
91	,93808	—	91,07	185,55	5,52	53,90	,5418	41	,96624	—	202,13	295,17	6,96	33,88	,3406
100 + 90	,93856	—	92,08	186,53	5,55	53,61	,5389	100 + 40	,96682	—	207,19	300,22	6,97	33,31	,3348
89	,93906	—	93,12	187,54	5,58	53,32	,5360	39	,96739	—	212,50	305,52	6,98	32,73	,3290
88	,93956	—	94,18	188,56	5,62	53,03	,5331	38	,96798	—	218,09	311,12	6,97	32,14	,3231
87	,94007	—	95,26	189,61	5,65	52,74	,5301	37	,96856	—	223,99	317,02	6,97	31,54	,3170
86	,94058	—	96,37	190,69	5,68	52,44	,5271	36	,96914	—	230,21	323,25	6,96	30,93	,3109
100 + 85	,94108	—	97,50	191,79	5,71	52,14	,5241	100 + 35	,96972	—	236,78	329,84	6,94	30,32	,3047
84	,94161	—	98,65	192,92	5,73	51,84	,5211	34	,97029	—	243,75	336,82	6,93	29,69	,2984
83	,94214	—	99,84	194,07	5,77	51,53	,5180	33	,97088	—	251,14	344,24	6,90	29,05	,2920
82	,94267	—	101,07	195,25	5,82	51,22	,5148	32	,97146	—	258,99	352,12	6,87	28,40	,2855
81	,94320	—	102,31	196,47	5,84	50,90	,5116	31	,97204	—	267,34	360,50	6,84	27,74	,2789
100 + 80	,94373	—	103,59	197,71	5,88	50,58	,5084	100 + 30	,97264	—	276,25	369,46	6,79	27,07	,2721
79	,94427	—	104,90	198,99	5,91	50,25	,5052	29	,97323	—	285,78	379,03	6,75	26,38	,2652
78	,94481	—	106,25	200,29	5,96	49,92	,5019	28	,97384	—	295,98	389,28	6,70	25,69	,2582
77	,94536	—	107,63	201,64	5,99	49,59	,4986	27	,97446	—	306,95	400,30	6,65	24,98	,2511
76	,94590	—	109,05	203,03	6,02	49,25	,4952	26	,97508	—	318,75	412,17	6,58	24,26	,2439
100 + 75	,94644	—	110,50	204,44	6,06	48,91	,4917	100 + 25	,97572	—	331,50	424,97	6,53	23,53	,2366
74	,94698	—	111,99	205,91	6,08	48,56	,4882	24	,97635	—	345,32	438,84	6,48	22,78	,2291
73	,94754	—	113,52	207,40	6,12	48,21	,4847	23	,97701	—	360,33	453,92	6,41	22,03	,2215
72	,94809	—	115,10	208,96	6,14	47,86	,4811	22	,97768	—	376,71	470,38	6,33	21,26	,2137
71	,94864	—	116,72	210,54	6,18	47,50	,4774	21	,97836	—	394,65	488,40	6,25	20,47	,2058
100 + 70	,94920	—	118,39	212,17	6,22	47,13	,4737	100 + 20	,97906	—	414,38	508,22	6,16	19,67	,1978
69	,94976	—	120,10	213,85	6,25	46,76	,4700	19	,97977	—	436,19	530,12	6,07	18,86	,1896
68	,95034	—	121,87	215,59	6,28	46,38	,4663	18	,98049	—	460,43	554,46	5,97	18,03	,1813
67	,95091	—	123,69	217,37	6,32	46,00	,4625	17	,98124	—	487,51	581,65	5,86	17,19	,1728
66	,95148	—	125,57	219,21	6,36	45,62	,4586	16	,98202	—	517,98	612,24	5,74	16,33	,1642
100 + 65	,95206	—	127,50	221,10	6,40	45,23	,4546	100 + 15	,98283	—	552,51	646,89	5,62	15,46	,1554
64	,95264	—	129,49	223,07	6,42	44,83	,4506	14	,98366	—	591,98	686,50	5,48	14,57	,1464
63	,95322	—	131,54	225,09	6,45	44,43	,4466	13	,98453	—	637,51	732,17	5,34	13,66	,1373
62	,95380	—	133,67	227,18	6,49	44,02	,4425	12	,98543	—	690,64	785,44	5,20	12,73	,1280
61	,95440	—	135,86	229,34	6,52	43,61	,4383	11	,98638	—	753,42	848,38	5,04	11,79	,1185
100 + 60	,95499	—	138,12	231,57	6,55	43,19	,4341	100 + 10	,98737	—	828,76	923,87	4,89	10,82	,1088
59	,95558	—	140,45	233,87	6,58	42,76	,4298	9	,98839	—	920,86	1016,15	4,71	9,84	,0989
58	,95619	—	142,88	236,25	6,63	42,32	,4255	8	,98948	—	1035,96	1131,44	4,52	8,84	,0888
57	,95678	—	145,39	238,72	6,67	41,89	,4211	7	,99063	—	1183,96	1279,62	4,34	7,81	,0785
56	,95737	—	147,99	241,30	6,69	41,44	,4166	6	,99184	—	1381,28	1477,14	4,14	6,77	,0680
100 + 55	,95798	—	150,68	243,96	6,72	40,99	,4120	100 + 5	,99310	—	1657,54	1753,61	3,93	5,70	,0573
54	,95857	—	153,45	246,72	6,73	40,53	,4075	4	,99443	—	2071,91	2168,21	3,70	4,61	,0464
53	,95916	—	156,33	249,58	6,75	40,06	,4028	3	,99586	—	2762,56	2859,06	3,50	3,50	,0352
52	,95976	—	159,34	252,56	6,78	39,59	,3980	2	,99737	—	4143,84	4240,54	3,30	2,36	,0237
51	,96035	—	162,48	255,66	6,82	39,11	,3932	1	,99896	—	8287,67	8384,55	3,12	1,19	,0120

TABLE I. HEAT 52°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82881	100	—	100,00	—	100,00	1,0046
1	,83112	—	0,83	100,72	0,11	99,29	,9975
2	,83337	—	1,66	101,44	0,22	98,58	,9904
3	,83558	—	2,49	102,16	0,33	97,88	,9834
4	,83771	—	3,32	102,89	0,43	97,19	,9764
100 + 5	,83980	—	4,15	103,63	0,52	96,50	,9695
6	,84183	—	4,97	104,36	0,61	95,82	,9627
7	,84381	—	5,80	105,10	0,70	95,15	,9560
8	,84574	—	6,63	105,84	0,79	94,48	,9493
9	,84762	—	7,45.	106,58	0,87	93,82	,9427
100 + 10	,84946	—	8,28	107,33	0,95	93,17	,9361
11	,85126	—	9,11	108,08	1,03	92,53	,9296
12	,85302	—	9,94	108,82	1,12	91,89	,9232
13	,85474	—	10,77	109,57	1,20	91,26	,9169
14	,85643	—	11,60	110,33	1,27	90,64	,9106
100 + 15	,85808	—	12,43	111,08	1,35	90,02	,9044
16	,85969	—	13,25	111,83	1,42	89,42	,8983
17	,86126	—	14,08	112,59	1,49	88,82	,8923
18	,86280	—	14,91	113,35	1,56	88,22	,8863
19	,86433	—	15,73	114,11	1,62	87,63	,8804
100 + 20	,86582	—	16,56	114,87	1,69	87,05	,8746
21	,86729	—	17,39	115,63	1,76	86,48	,8688
22	,86873	—	18,22	116,39	1,83	85,92	,8631
23	,87015	—	19,05	117,15	1,90	85,36	,8575
24	,87154	—	19,88	117,92	1,96	84,81	,8520
100 + 25	,87291	—	20,71	118,69	2,02	84,26	,8465
26	,87425	—	21,54	119,45	2,09	83,72	,8410
27	,87556	—	22,37	120,22	2,15	83,18	,8357
28	,87685	—	23,20	120,99	2,21	82,65	,8304
29	,87812	—	24,02	121,76	2,26	82,13	,8252
100 + 30	,87937	—	24,86	122,53	2,33	81,62	,8199
31	,88060	—	25,68	123,30	2,38	81,11	,8148
32	,88181	—	26,50	124,07	2,43	80,60	,8097
33	,88300	—	27,33	124,84	2,49	80,10	,8047
34	,88418	—	28,16	125,61	2,55	79,61	,7998
100 + 35	,88533	—	28,99	126,39	2,60	79,13	,7949
36	,88647	—	29,82	127,16	2,66	78,65	,7901
37	,88758	—	30,65	127,92	2,73	78,17	,7853
38	,88868	—	31,48	128,70	2,78	77,70	,7806
39	,88976	—	32,30	129,47	2,83	77,23	,7759
100 + 40	,89083	—	33,13	130,25	2,88	76,77	,7713
41	,89188	—	33,96	131,03	2,93	76,32	,7667
42	,89292	—	34,79	131,80	2,99	75,87	,7622
43	,89394	—	35,61	132,58	3,03	75,42	,7578
44	,89495	—	36,44	133,36	3,08	74,98	,7534
100 + 45	,89593	—	37,27	134,14	3,13	74,55	,7490
46	,89692	—	38,10	134,91	3,19	74,12	,7446
47	,89789	—	38,93	135,69	3,24	73,70	,7404
48	,89884	—	39,76	136,47	3,29	73,28	,7362
49	,89978	—	40,58	137,25	3,33	72,86	,7320

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90069	100	41,41	138,03	3,38	72,45	,7278
51	,90160	—	42,24	138,81	3,43	72,04	,7237
52	,90248	—	43,07	139,59	3,48	71,64	,7197
53	,90336	—	43,90	140,37	3,53	71,24	,7157
54	,90421	—	44,73	141,16	3,57	70,84	,7118
100 + 55	,90505	—	45,56	141,94	3,62	70,45	,7078
56	,90588	—	46,38	142,73	3,65	70,06	,7039
57	,90669	—	47,21	143,51	3,70	69,68	,7001
58	,90749	—	48,04	144,30	3,74	69,30	,6962
59	,90828	—	48,87	145,08	3,79	68,92	,6924
100 + 60	,90906	—	49,69	145,87	3,82	68,55	,6887
61	,90982	—	50,52	146,66	3,86	68,18	,6850
62	,91059	—	51,36	147,45	3,91	67,82	,6814
63	,91134	—	52,18	148,23	3,95	67,46	,6778
64	,91206	—	53,01	149,03	3,98	67,10	,6741
100 + 65	,91279	—	53,84	149,82	4,02	66,75	,6706
66	,91352	—	54,67	150,61	4,06	66,40	,6671
67	,91424	—	55,50	151,39	4,11	66,05	,6636
68	,91496	—	56,32	152,18	4,14	65,71	,6602
69	,91566	—	57,15	152,97	4,18	65,37	,6568
100 + 70	,91634	—	57,98	153,76	4,22	65,03	,6534
71	,91703	—	58,81	154,55	4,26	64,70	,6501
72	,91770	—	59,64	155,34	4,30	64,37	,6468
73	,91836	—	60,46	156,13	4,33	64,04	,6435
74	,91901	—	61,29	156,92	4,37	63,73	,6402
100 + 75	,91966	—	62,12	157,71	4,41	63,41	,6370
76	,92028	—	62,95	158,50	4,45	63,09	,6338
77	,92090	—	63,78	159,29	4,49	62,78	,6306
78	,92153	—	64,61	160,09	4,52	62,47	,6275
79	,92214	—	65,44	160,88	4,56	62,16	,6245
100 + 80	,92274	—	66,27	161,68	4,59	61,85	,6214
81	,92333	—	67,09	162,47	4,62	61,55	,6184
82	,92392	—	67,92	163,27	4,65	61,25	,6154
83	,92450	—	68,75	164,06	4,69	60,95	,6124
84	,92507	—	69,57	164,86	4,71	60,66	,6094
100 + 85	,92562	—	70,41	165,65	4,76	60,37	,6065
86	,92619	—	71,24	166,45	4,79	60,08	,6036
87	,92674	—	72,06	167,24	4,82	59,80	,6007
88	,92728	—	72,89	168,03	4,86	59,51	,5979
89	,92782	—	73,72	168,83	4,89	59,23	,5951
100 + 90	,92835	—	74,55	169,62	4,93	58,95	,5922
91	,92887	—	75,38	170,42	4,96	58,68	,5895
92	,92939	—	76,21	171,22	4,99	58,40	,5867
93	,92991	—	77,03	172,02	5,01	58,13	,5840
94	,93042	—	77,86	172,81	5,05	57,86	,5813
100 + 95	,93092	—	78,69	173,61	5,08	57,60	,5787
96	,93141	—	79,51	174,40	5,11	57,34	,5760
97	,93191	—	80,33	175,19	5,14	57,08	,5734
98	,93239	—	81,16	175,98	5,18	56,82	,5708
99	,93287	—	81,99	176,78	5,21	56,56	,5682

TABLE II. HEAT 52°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93334	100	82,83	177,59	5,24	56,30	,5657
99	,93383	—	83,67	178,41	5,26	56,05	,5631
98	,93432	—	84,53	179,24	5,29	55,79	,5605
97	,93479	—	85,41	180,08	5,33	55,53	,5579
96	,93528	—	86,29	180,93	5,36	55,27	,5553
100 + 95	,93575	—	87,19	181,80	5,39	55,00	,5526
94	,93623	—	88,12	182,70	5,42	54,73	,5499
93	,93672	—	89,06	183,62	5,44	54,46	,5471
92	,93720	—	90,03	184,56	5,47	54,19	,5443
91	,93768	—	91,02	185,53	5,49	53,91	,5415
100 + 90	,93816	—	92,03	186,50	5,53	53,62	,5387
89	,93866	—	93,07	187,51	5,57	53,33	,5358
88	,93916	—	94,13	188,53	5,60	53,04	,5329
87	,93967	—	95,21	189,58	5,63	52,75	,5299
86	,94018	—	96,32	190,66	5,66	52,45	,5269
100 + 85	,94068	—	97,45	191,76	5,69	52,15	,5239
84	,94121	—	98,60	192,89	5,71	51,85	,5209
83	,94173	—	99,79	194,04	5,75	51,54	,5178
82	,94226	—	101,01	195,22	5,79	51,22	,5146
81	,94280	—	102,26	196,44	5,82	50,91	,5114
100 + 80	,94333	—	103,54	197,68	5,86	50,59	,5082
79	,94387	—	104,85	198,96	5,89	50,26	,5050
78	,94441	—	106,20	200,26	5,94	49,93	,5017
77	94496	—	107,57	201,61	5,96	49,59	,4984
76	,94550	—	108,99	202,99	6,00	49,26	,4950
100 + 75	,94604	—	110,44	204,41	6,03	48,92	,4915
74	,94659	—	111,93	205,87	6,06	48,57	,4880
73	,94715	—	113,46	207,37	6,09	48,22	,4845
72	,94770	—	115,04	208,92	6,12	47,86	,4809
71	,94825	—	116,66	210,51	6,15	47,50	,4773
100 + 70	,94881	—	118,33	212,14	6,19	47,14	,4736
69	,94938	—	120,04	213,82	6,22	46,76	,4699
68	,94996	—	121,80	215,55	6,25	46,39	,4661
67	,95053	—	123,62	217,33	6,29	46,01	,4623
66	,95110	—	125,50	219,17	6,33	45,62	,4584
100 + 65	,95169	—	127,43	221,06	6,37	45,23	,4544
64	,95227	—	129,42	223,02	6,40	44,83	,4505
63	,95285	—	131,47	225,04	6,43	44,43	,4464
62	,95344	—	133,60	227,13	6,47	44 02	,4423
61	,95404	—	135,79	229,29	6,50	43,61	,4382
100 + 60	,95463	—	138,05	231,52	6,53	43,19	,4339
59	,95523	—	140,38	233,82	6,56	42,77	,4297
58	,95584	—	142,80	236,20	6,60	42,33	,4253
57	,95643	—	145,31	238,67	6,64	41,89	,4209
56	,95703	—	147,91	241,24	6,67	41,45	,4164
100 + 55	,95764	—	150,60	243,90	6,70	41,00	,4119
54	,95823	—	153,37	246,66	6,71	40,54	,4073
53	,95883	—	156,25	249,52	6,73	40,07	,4026
52	,95943	—	159,26	252,50	6,76	39,60	,3979
51	,96002	—	162,39	255,60	6,79	39,12	,3930

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96062	100	165,66	258,83	6,83	38,63	,3881
49	,96122	—	169,05	262,20	6,85	38,14	,3832
48	,96182	—	172,57	265,69	6,88	37,63	,3781
47	,96242	—	176,23	269,34	6,89	37,13	,3730
46	,96301	—	180,06	273,16	6,90	36,61	,3678
100 + 45	,96362	—	184,07	277,16	6,91	36,08	,3625
44	,96420	—	188,26	281,32	6,94	35,54	,3571
43	,96479	—	192,63	285,69	6,94	35,00	,3516
42	,96538	—	197,21	290,28	6,93	34,45	,3461
41	,96597	—	202,02	295,08	6,94	33,89	,3405
100 + 40	,96655	—	207,08	300,12	6,96	33,32	,3347
39	,96713	—	212,39	305,43	6,96	32,74	,3289
38	,96772	—	217,97	311,02	6,95	32,15	,3230
37	,96831	—	223,87	316,93	6,94	31,55	,3169
36	,96890	—	230,09	323,15	6,94	30,94	,3108
100 + 35	,96949	—	236,66	329,73	6,93	30,33	,3047
34	,97006	—	243,62	336,71	6,91	29,70	,2984
33	,97065	—	251,01	344,12	6,89	29,06	,2920
32	,97124	—	258,85	352,00	6,85	28,41	,2855
31	,97183	—	267,20	360,37	6,83	27,75	,2788
100 + 30	,97244	—	276,10	369,32	6,78	27,08	,2720
29	,97303	—	285,63	378,89	6,74	26,39	,2651
28	,97364	—	295,82	389,13	6,69	25,70	,2581
27	,97427	—	306,79	400,14	6,65	24,99	,2510
26	,97490	—	318,58	412,00	6,58	24,27	,2438
100 + 25	,97554	—	331,33	424,80	6,53	23,54	,2365
24	,97618	—	345,14	438,66	6,48	22,79	,2290
23	,97684	—	360,14	453,73	6,41	22,04	,2214
22	,97752	—	376,51	470,18	6,33	21,27	,2136
21	,97821	—	394,44	488,19	6,25	20,48	,2058
100 + 20	,97892	—	414,16	508,00	6,16	19,68	,1978
19	,97963	—	435,96	529,88	6,08	18,87	,1896
18	,98036	—	460,19	554,21	5,98	18,04	,1813
17	,98112	—	487,25	581,38	5,87	17,20	,1728
16	,98190	—	517,71	611,95	5,76	16,34	,1642
100 + 15	,98272	—	552,22	646,58	5,64	15,47	,1554
14	,98355	—	591,67	686,17	5,50	14,57	,1464
13	,98443	—	637,18	731,81	5,37	13,66	,1373
12	,98534	—	690,28	785,06	5,22	12,74	,1280
11	,98629	—	753,03	847,96	5,07	11,80	,1185
100 + 10	,98729	—	828,33	923,41	4,92	10,83	,1088
9	,98831	—	920,38	1015,64	4,74	9,85	,0989
8	,9894c	—	1035,42	1130,87	4,55	8,84	,0888
7	,99056	—	1183,34	1278,97	4,37	7,82	,0785
6	,99177	—	1380,56	1476,38	4,18	6,77	,0680
100 + 5	,99304	—	1656,67	1752,70	3,97	5,70	,0573
4	,99437	—	2070,83	2167,08	3,75	4,61	,0464
3	,99580	—	2761,11	2857,56	3,55	3,50	,0352
2	,99731	—	4141,66	4238,31	3,35	2,36	,0237
1	,99890	—	8283,32	8380,15	3,17	1,19	,0120

TABLE I. HEAT 53°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82833	100	—	100,00	—	100,00	1,0040
1	,83063	—	0,83	100,72	0,11	99,29	,9969
2	,83288	—	1,66	101,44	0,22	98,58	,9898
3	,83509	—	2,49	102,16	0,33	97,88	,9828
4	,83723	—	3,32	102,89	0,43	97,19	,9758
100 + 5	,83932	—	4,14	103,63	0,51	96,50	,9689
6	,84135	—	4,97	104,36	0,61	95,82	,9622
7	,84332	—	5,80	105,10	0,70	95,15	,9555
8	,84526	—	6,63	105,84	0,79	94,48	,9488
9	,84714	—	7,45	106,58	0,87	93,82	,9422
100 + 10	,84898	—	8,28	107,33	0,95	93,17	,9355
11	,85078	—	9,11	108,08	1,03	92,53	,9291
12	,85254	—	9,93	108,82	1,11	91,90	,9227
13	,85426	—	10,76	109,57	1,19	91,27	,9164
14	,85595	—	11,59	110,33	1,26	90,65	,9101
100 + 15	,85760	—	12,42	111,08	1,34	90,03	,9039
16	,85921	—	13,25	111,83	1,42	89,42	,8978
17	,86078	—	14,07	112,59	1,48	88,82	,8918
18	,86233	—	14,90	113,35	1,55	88,22	,8858
19	,86386	—	15,72	114,10	1,62	87,63	,8799
100 + 20	,86535	—	16,56	114,87	1,69	87,05	,8741
21	,86682	—	17,39	115,63	1,76	86,48	,8684
22	,86826	—	18,21	116,39	1,82	85,92	,8627
23	,86968	—	19,04	117,15	1,89	85,36	,8571
24	,87107	—	19,87	117,91	1,96	84,81	,8516
100 + 25	,87244	—	20,70	118,68	2,02	84,26	,8460
26	,87378	—	21,52	119,44	2,08	83,72	,8406
27	,87509	—	22,35	120,21	2,14	83,18	,8352
28	,87638	—	23,19	120,98	2,21	82,66	,8299
29	,87765	—	24,01	121,75	2,26	82,13	,8247
100 + 30	,87890	—	24,84	122,52	2,32	81,62	,8195
31	,88013	—	25,67	123,29	2,38	81,11	,8144
32	,88134	—	26,48	124,06	2,42	80,61	,8093
33	,88254	—	27,32	124,83	2,49	80,11	,8043
34	,88371	—	28,15	125,60	2,55	79,62	,7994
100 + 35	,88486	—	28,98	126,38	2,60	79,13	,7945
36	,88600	—	29,80	127,15	2,65	78,65	,7897
37	,88712	—	30,63	127,92	2,71	78,17	,7849
38	,88822	—	31,46	128,70	2,76	77,70	,7802
39	,88930	—	32,28	129,47	2,81	77,23	,7755
100 + 40	,89037	—	33,12	130,25	2,87	76,78	,7709
41	,89142	—	33,95	131,02	2,93	76,32	,7663
42	,89246	—	34,78	131,79	2,99	75,87	,7618
43	,89349	—	35,60	132,57	3,03	75,43	,7574
44	,89450	—	36,43	133,35	3,08	74,99	,7530
100 + 45	,89548	—	37,26	134,13	3,13	74,55	,7486
46	,89647	—	38,08	134,90	3,18	74,13	,7443
47	,89744	—	38,91	135,68	3,23	73,70	,7400
48	,89839	—	39,74	136,46	3,28	73,28	,7358
49	,89933	—	40,56	137,24	3,32	72,86	,7316

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,90024	100	41,39	138,02	3,37	72,46	,7275
51	,90114	—	42,22	138,80	3,42	72,05	,7234
52	,90203	—	43,05	139,58	3,47	71,64	,7194
53	,90290	—	43,87	140,36	3,51	71,24	,7154
54	,90375	—	44,70	141,15	3,55	70,85	,7114
100 + 55	,90459	—	45,53	141,93	3,60	70,46	,7074
56	,90542	—	46,35	142,72	3,63	70,07	,7036
57	,90623	—	47,18	143,50	3,68	69,68	,6997
58	,90703	—	48,01	144,29	3,72	69,30	,6958
59	,90782	—	48,84	145,07	3,77	68,93	,6921
100 + 60	,90860	—	49,67	145,86	3,81	68,56	,6883
61	,90937	—	50,50	146,65	3,85	68,19	,6846
62	,91013	—	51,33	147,44	3,89	67,82	,6811
63	,91088	—	52,15	148,22	3,93	67,46	,6775
64	,91161	—	52,98	149,01	3,97	67,11	,6738
100 + 65	,91234	—	53,81	149,80	4,01	66,76	,6702
66	,91307	—	54,64	150,59	4,05	66,41	,6667
67	,91379	—	55,47	151,37	4,10	66,06	,6633
68	,91451	—	56,29	152,16	4,13	65,72	,6599
69	,91522	—	57,12	152,95	4,17	65,38	,6565
100 + 70	,91590	—	57,95	153,74	4,21	65,04	,6531
71	,91659	—	58,78	154,53	4,25	64,71	,6498
72	,91726	—	59,61	155,32	4,29	64,38	,6465
73	,91793	—	60,43	156,11	4,32	64,05	,6432
74	,91858	—	61,26	156,90	4,36	63,73	,6399
100 + 75	,91923	—	62,09	157,69	4,40	63,41	,6367
76	,91986	—	62,91	158,48	4,43	63,09	,6335
77	,92048	—	63,75	159,27	4,48	62,78	,6303
78	,92110	—	64,57	160,08	4,49	62,47	,6272
79	,92171	—	65,41	160,86	4,55	62,16	,6242
100 + 80	,92231	—	66,23	161,66	4,57	61,86	,6211
81	,92290	—	67,05	162,46	4,59	61,55	,6181
82	,92349	—	67,88	163,25	4,63	61,25	,6151
83	,92407	—	68,71	164,04	4,67	60,96	,6121
84	,92464	—	69,53	164,84	4,69	60,66	,6091
100 + 85	,92520	—	70,37	165,63	4,74	60,37	,6062
86	,92577	—	71,20	166,42	4,78	60,09	,6033
87	,92632	—	72,02	167,22	4,80	59,81	,6004
88	,92686	—	72,85	168,01	4,84	59,52	,5976
89	,92740	—	73,68	168,81	4,87	59,24	,5948
100 + 90	,92793	—	74,51	169,60	4,91	58,96	,5920
91	,92844	—	75,34	170,40	4,94	58,68	,5892
92	,92897	—	76,17	171,20	4,97	58,41	,5865
93	,92948	—	76,99	172,00	4,99	58,14	,5838
94	,92999	—	77,82	172,79	5,03	57,87	,5811
100 + 95	,93049	—	78,65	173,59	5,06	57,61	,5784
96	,93098	—	79,47	174,38	5,09	57,35	,5758
97	,93148	—	80,29	175,17	5,12	57,09	,5732
98	,93197	—	81,12	175,96	5,16	56,83	,5706
99	,93244	—	81,95	176,76	5,19	56,57	,5680

TABLE II. HEAT 53°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93291	100	82,78	177,57	5,21	56,31	,5654
99	,93341	—	83,63	178,38	5,25	56,05	,5628
98	,93390	—	84,49	179,22	5,27	55,79	,5602
97	,93438	—	85,36	180,06	5,30	55,53	,5576
96	,93486	—	86,24	180,91	5,33	55,27	,5550
100 + 95	,93534	—	87,14	181,78	5,36	55,01	,5523
94	,93582	—	88,08	182,68	5,40	54,74	,5496
93	,93631	—	89,01	183,59	5,42	54,47	,5469
92	,93679	—	89,98	184,53	5,45	54,19	,5441
91	,93728	—	90,97	185,50	5,47	53,91	,5413
100 + 90	,93776	—	91,98	186,47	5,51	53,62	,5384
89	,93826	—	93,02	187,48	5,54	53,33	,5356
88	,93876	—	94,08	188,50	5,58	53,05	,5327
87	,93927	—	95,16	189,55	5,61	52,75	,5297
86	,93978	—	96,27	190,63	5,64	52,45	,5267
100 + 85	,94028	—	97,40	191,73	5,67	52,15	,5237
84	,94081	—	98,55	192,86	5,69	51,85	,5207
83	,94133	—	99,74	194,01	5,73	51,55	,5176
82	,94186	—	100,96	195,19	5,77	51,23	,5144
81	,94240	—	102,20	196,41	5,79	50,91	,5112
100 + 80	,94293	—	103,48	197,65	5,83	50,59	,5080
79	,94347	—	104,79	198,92	5,87	50,27	,5048
78	,94401	—	106,14	200,23	5,91	49,94	,5015
77	,94456	—	107,51	201,58	5,93	49,60	,4982
76	,94510	—	108,93	202,96	5,97	49,27	,4948
100 + 75	,94564	—	110,38	204,38	6,00	48,93	,4913
74	,94620	—	111,87	205,83	6,04	48,58	,4878
73	,94676	—	113,40	207,34	6,06	48,23	,4843
72	,94731	—	114,98	208,89	6,09	47,87	,4807
71	,94787	—	116,60	210,47	6,13	47,51	,4771
100 + 70	,94843	—	118,27	212,11	6,16	47,14	,4734
69	,94900	—	119,96	213,78	6,20	46,77	,4697
68	,94958	—	121,74	215,51	6,24	46,40	,4659
67	,95015	—	123,56	217,29	6,27	46,02	,4621
66	,95073	—	125,44	219,13	6,31	45,63	,4582
100 + 65	,95131	—	127,37	221,02	6,35	45,24	,4543
64	,95190	—	129,35	222,98	6,37	44,84	,4503
63	,95249	—	131,40	225,00	6,40	44,44	,4462
62	,95308	—	133,53	227,09	6,44	44,03	,4421
61	,95368	—	135,72	229,25	6,47	43,62	,4380
100 + 60	,95428	—	137,98	231,47	6,51	43,20	,4338
59	,95488	—	140,31	233,77	6,54	42,77	,4295
58	,95549	—	142,72	236,15	6,57	42,34	,4251
57	,95609	—	145,24	238,62	6,62	41,90	,4207
56	,95669	—	147,83	241,19	6,64	41,46	,4163
100 + 55	,95730	—	150,52	243,85	6,67	41,01	,4117
54	,95790	—	153,29	246,60	6,69	40,55	,4071
53	,95850	—	156,17	249,46	6,71	40,08	,4025
52	,95910	—	159,18	252,44	6,74	39,61	,3978
51	,95970	—	162,31	255,54	6,77	39,13	,3929

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,96030	100	165,57	258,76	6,81	38,64	,3880
49	,96091	—	168,96	262,14	6,82	38,14	,3831
48	,96151	—	172,48	265,62	6,86	37,64	,3780
47	,96211	—	176,14	269,27	6,87	37,14	,3729
46	,96271	—	179,97	273,08	6,89	36,62	,3677
100 + 45	,96332	—	183,97	277,08	6,89	36,09	,3624
44	,96391	—	188,16	281,24	6,92	35,55	,3570
43	,96450	—	192,53	285,60	6,93	35,01	,3515
42	,96510	—	197,11	290,19	6,92	34,46	,3460
41	,96570	—	201,92	294,99	6,93	33,90	,3404
100 + 40	,96628	—	206,97	300,03	6,94	33,33	,3346
39	,96687	—	212,28	305,34	6,94	32,75	,3288
38	,96747	—	217,86	310,93	6,93	32,16	,3229
37	,96806	—	223,75	316,83	6,92	31,56	,3169
36	,96866	—	229,97	323,05	6,92	30,95	,3108
100 + 35	,96925	—	236,54	329,62	6,92	30,34	,3046
34	,96983	—	243,50	336,59	6,91	29,71	,2983
33	,97043	—	250,88	344,00	6,88	29,07	,2919
32	,97102	—	258,71	351,87	6,84	28,42	,2854
31	,97162	—	267,06	360,24	6,82	27,76	,2788
100 + 30	,97223	—	275,96	369,19	6,77	27,09	,2719
29	,97283	—	285,48	378,75	6,73	26,40	,2651
28	,97345	—	295,67	388,98	6,69	25,71	,2581
27	,97408	—	306,63	399,98	6,65	25,00	,2510
26	,97472	—	318,41	411,83	6,58	24,28	,2438
100 + 25	,97536	—	331,16	424,63	6,53	23,55	,2364
24	,97601	—	344,96	438,48	6,48	22,80	,2290
23	,97668	—	359,95	453,54	6,41	22,05	,2214
22	,97736	—	376,31	469,98	6,33	21,28	,2136
21	,97806	—	394,23	487,98	6,25	20,49	,2057
100 + 20	,97877	—	413,94	507,78	6,16	19,69	,1977
19	,97949	—	435,73	529,65	6,08	18,88	,1895
18	,98023	—	459,95	553,96	5,99	18,05	,1812
17	,98100	—	487,00	581,12	5,88	17,21	,1727
16	,98179	—	517,44	611,66	5,78	16,35	,1641
100 + 15	,98261	—	551,93	646,28	5,65	15,48	,1553
14	,98345	—	591,36	685,84	5,52	14,58	,1463
13	,98433	—	636,85	731,46	5,39	13,67	,1372
12	,98525	—	689,92	784,68	5,24	12,74	,1280
11	,98620	—	752,64	847,54	5,10	11,80	,1185
100 + 10	,98720	—	827,90	922,95	4,95	10,84	,1088
9	,98823	—	919,90	1015,13	4,77	9,85	,0989
8	,98933	—	1034,88	1130,30	4,58	8,84	,0888
7	,99049	—	1182,72	1278,32	4,40	7,82	,0786
6	,99170	—	1379,84	1475,62	4,22	6,78	,0680
100 + 5	,99298	—	1655,81	1751,79	4,02	5,71	,0573
4	,99431	—	2069,75	2165,96	3,79	4,62	,0464
3	,99574	—	2759,66	2856,06	3,60	3,50	,0352
2	,99725	—	4139,50	4236,09	3,41	2,36	,0237
1	,99884	—	8279,00	8375,77	3,23	1,19	,0120

TABLE I. HEAT 54°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82784	100	—	100,00	—	100,00	1,0034
1	,83015	—	0,83	100,72	0,11	99,29	,9963
2	,83240	—	1,66	101,44	0,22	98,58	,9892
3	,83460	—	2,49	102,16	0,33	97,88	,9822
4	,83674	—	3,31	102,89	0,42	97,19	,9752
100 + 5	,83883	—	4,14	103,63	0,51	96,50	,9683
6	,84086	—	4,96	104,36	0,60	95,82	,9616
7	,84283	—	5,79	105,10	0,69	95,15	,9549
8	,84477	—	6,62	105,84	0,78	94,48	,9482
9	,84666	—	7,45	106,58	0,87	93,83	,9416
100 + 10	,84850	—	8,28	107,32	0,96	93,18	,9350
11	,85030	—	9,11	108,07	1,04	92,54	,9286
12	,85206	—	9,93	108,82	1,11	91,90	,9222
13	,85378	—	10,76	109,57	1,19	91,27	,9159
14	,85547	—	11,59	110,32	1,27	90,65	,9096
100 + 15	,85712	—	12,41	111,08	1,33	90,03	,9034
16	,85873	—	13,24	111,83	1,41	89,42	,8973
17	,86031	—	14,07	112,58	1,49	88,82	,8913
18	,86186	—	14,90	113,34	1,56	88,23	,8853
19	,86339	—	15,71	114,10	1,61	87,64	,8794
100 + 20	,86488	—	16,55	114,86	1,69	87,06	,8736
21	,86635	—	17,38	115,62	1,76	86,49	,8679
22	,86779	—	18,20	116,38	1,82	85,92	,8622
23	,86921	—	19,03	117,14	1,89	85,36	,8566
24	,87060	—	19,86	117,91	1,95	84,81	,8511
100 + 25	,87197	—	20,69	118,68	2,01	84,26	,8455
26	,87331	—	21,51	119,44	2,07	83,72	,8401
27	,87462	—	22,34	120,21	2,13	83,19	,8348
28	,87591	—	23,18	120,98	2,20	82,66	,8295
29	,87718	—	23,99	121,75	2,24	82,14	,8243
100 + 30	,87843	—	24,83	122,52	2,31	81,62	,8190
31	,87966	—	25,65	123,29	2,36	81,11	,8139
32	,88087	—	26,47	124,06	2,41	80,61	,8088
33	,88207	—	27,30	124,83	2,47	80,11	,8039
34	,88324	—	28,14	125,60	2,54	79,62	,7990
100 + 35	,88439	—	28,96	126,37	2,59	79,13	,7941
36	,88554	—	29,79	127,14	2,65	78,65	,7893
37	,88666	—	30,62	127,91	2,71	78,18	,7845
38	,88776	—	31,45	128,69	2,76	77,71	,7798
39	,88884	—	32,26	129,46	2,80	77,24	,7751
100 + 40	,88991	—	33,10	130,24	2,86	76,78	,7705
41	,89097	—	33,93	131,01	2,92	76,33	,7659
42	,89201	—	34,76	131,78	2,98	75,88	,7614
43	,89304	—	35,58	132,56	3,02	75,43	,7570
44	,89405	—	36,41	133,34	3,07	74,99	,7526
100 + 45	,89503	—	37,24	134,12	3,12	74,56	,7482
46	,89602	—	38,06	134,89	3,17	74,13	,7438
47	,89699	—	38,89	135,67	3,22	73,71	,7396
48	,89794	—	39,72	136,45	3,27	73,29	,7354
49	,89887	—	40,54	137,23	3,31	72,87	,7312

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89978	100	41,37	138,01	3,36	72,46	,7271
51	,90068	—	42,20	138,79	3,41	72,05	,7230
52	,90157	—	43,03	139,57	3,46	71,65	,7190
53	,90244	—	43,85	140,35	3,50	71,25	,7150
54	,90329	—	44,68	141,14	3,54	70,85	,7110
100 + 55	,90413	—	45,51	141,92	3,59	70,46	,7071
56	,90496	—	46,33	142,71	3,62	70,07	,7032
57	,90577	—	47,16	143,49	3,67	69,69	,6993
58	,90657	—	47,99	144,28	3,71	69,31	,6955
59	,90736	—	48,81	145,06	3,75	68,93	,6917
100 + 60	,90814	—	49,64	145,85	3,79	68,56	,6880
61	,90891	—	50,47	146,64	3,83	68,20	,6843
62	,90967	—	51,30	147,43	3,87	67,83	,6807
63	,91042	—	52,12	148,21	3,91	67,47	,6771
64	,91115	—	52,95	149,00	3,95	67,11	,6734
100 + 65	,91189	—	53,78	149,79	3,99	66,76	,6699
66	,91262	—	54,61	150,58	4,03	66,41	,6664
67	,91334	—	55,44	151,36	4,08	66,06	,6630
68	,91406	—	56,26	152,15	4,11	65,72	,6596
69	,91477	—	57,09	152,94	4,15	65,38	,6562
100 + 70	,91546	—	57,92	153,73	4,19	65,05	,6528
71	,91615	—	58,75	154,52	4,23	64,72	,6495
72	,91682	—	59,58	155,31	4,27	64,39	,6462
73	,91750	—	60,40	156,09	4,31	64,06	,6429
74	,91815	—	61,23	156,88	4,35	63,74	,6396
100 + 75	,91880	—	62,06	157,68	4,38	63,42	,6364
76	,91944	—	62,88	158,47	4,41	63,10	,6332
77	,92006	—	63,71	159,25	4,46	62,79	,6300
78	,92067	—	64,54	160,06	4,48	62,48	,6269
79	,92128	—	65,37	160,84	4,53	62,17	,6239
100 + 80	,92189	—	66,20	161,64	4,56	61,86	,6208
81	,92247	—	67,02	162,44	4,58	61,56	,6178
82	,92307	—	67,85	163,23	4,62	61,26	,6148
83	,92365	—	68,67	164,02	4,65	60,96	,6118
84	,92421	—	69,50	164,82	4,68	60,67	,6088
100 + 85	,92478	—	70,33	165,61	4,72	60,38	,6059
86	,92535	—	71,17	166,40	4,77	60,09	,6030
87	,92590	—	71,98	167,20	4,78	59,81	,6001
88	,92644	—	72,81	167,99	4,82	59,52	,5973
89	,92797	—	73,64	168,79	4,85	59,24	,5945
100 + 90	,92751	—	74,47	169,58	4,89	58,96	,5917
91	,92802	—	75,30	170,38	4,92	58,69	,5889
92	,92854	—	76,13	171,18	4,95	58,42	,5862
93	,92905	—	76,95	171,98	4,97	58,15	,5835
94	,92956	—	77,78	172,77	5,01	57,88	,5808
100 + 95	,93006	—	78,61	173,57	5,04	57,61	,5781
96	,93055	—	79,43	174,36	5,07	57,35	,5755
97	,93105	—	80,25	175,15	5,10	57,09	,5729
98	,93154	—	81,08	175,94	5,14	56,83	,5703
99	,93202	—	81,91	176,74	5,17	56,58	,5677

TABLE II. HEAT 54°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93249	100	82,74	177,55	5,19	56,32	,5652
99	,93299	—	83,59	178,36	5,23	56,06	,5626
98	,93348	—	84,44	179,19	5,25	55,80	,5600
97	,93396	—	85,32	180,04	5,28	55,54	,5574
96	,93445	—	86,20	180,89	5,31	55,28	,5548
100 + 95	,93493	—	87,10	181,76	5,34	55,02	,5521
94	,93541	—	88,03	182,66	5,37	54,75	,5494
93	,93590	—	88,96	183,57	5,39	54,47	,5466
92	,93639	—	89,93	184,50	5,43	54,20	,5439
91	,93688	—	90,92	185,47	5,45	53,92	,5410
100 + 90	,93736	—	91,93	186,44	5,49	53,63	,5382
89	,93786	—	92,97	187,45	5,52	53,34	,5353
88	,93836	—	94,03	188,47	5,56	53,05	,5324
87	,93887	—	95,11	189,52	5,59	52,76	,5295
86	,93938	—	96,22	190,60	5,62	52,46	,5265
100 + 85	,93988	—	97,35	191,70	5,65	52,16	,5235
84	,94041	—	98,50	192,83	5,67	51,86	,5205
83	,94092	—	99,69	193,98	5,71	51,55	,5174
82	,94146	—	100,91	195,16	5,75	51,24	,5142
81	,94200	—	102,15	196,38	5,77	50,92	,5110
100 + 80	,94253	—	103,43	197,62	5,81	50,60	,5078
79	,94307	—	104,74	198,89	5,85	50,28	,5046
78	,94361	—	106,08	200,20	5,88	49,95	,5013
77	,94416	—	107,46	201,55	5,91	49,61	,4980
76	,94471	—	108,87	202,93	5,94	49,28	,4946
100 + 75	,94525	—	110,32	204,35	5,97	48,93	,4910
74	,94581	—	111,81	205,80	6,01	48,59	,4876
73	,94637	—	113,34	207,30	6,04	48,24	,4841
72	,94693	—	114,92	208,85	6,07	47,88	,4805
71	,94749	—	116,54	210,44	6,10	47,52	,4769
100 + 70	,94805	—	118,21	212,07	6,14	47,15	,4732
69	,94862	—	119,92	213,74	6,18	46,78	,4695
68	,94920	—	121,68	215,47	6,21	46,41	,4657
67	,94978	—	123,50	217,25	6,25	46,03	,4619
66	,95036	—	125,37	219,09	6,28	45,64	,4580
100 + 65	,95094	—	127,31	220,98	6,33	45,25	,4541
64	,95153	—	129,28	222,94	6,34	44,85	,4501
63	,95213	—	131,33	224,95	6,38	44,45	,4461
62	,95272	—	133,46	227,04	6,42	44,04	,4420
61	,95332	—	135,65	229,20	6,45	43,63	,4378
100 + 60	,95393	—	137,91	231,42	6,49	43,21	,4336
59	,95453	—	140,24	233,72	6,52	42,78	,4293
58	,95514	—	142,65	236,10	6,55	42,35	,4250
57	,95575	—	145,16	238,57	6,59	41,91	,4206
56	,95635	—	147,76	241,14	6,62	41,47	,4162
100 + 55	,95696	—	150,44	243,80	6,64	41,02	,4116
54	,95757	—	153,21	246,54	6,67	40,56	,4070
53	,95817	—	156,09	249,40	6,69	40,09	,4024
52	,95877	—	159,10	252,38	6,72	39,62	,3977
51	,95938	—	162,23	255,48	6,75	39,14	,3928

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95998	100	165,49	258,70	6,79	38,65	,3879
49	,96059	—	168,87	262,08	6,79	38,15	,3830
48	,96120	—	172,39	265,55	6,84	37,65	,3779
47	,96181	—	176,05	269,20	6,85	37,15	,3728
46	,96241	—	179,88	273,01	6,87	36,63	,3676
100 + 45	,96302	—	183,88	277,00	6,88	36,10	,3623
44	,96362	—	188,06	281,16	6,90	35,56	,3569
43	,96422	—	192,43	285,52	6,91	35,02	,3514
42	,96482	—	197,01	290,10	6,91	34,47	,3459
41	,96543	—	201,82	294,90	6,92	33,91	,3403
100 + 40	,96601	—	206,86	299,94	6,92	33,34	,3345
39	,96661	—	212,17	305,25	6,92	32,76	,3287
38	,96722	—	217,75	310,83	6,92	32,17	,3228
37	,96781	—	223,64	316,74	6,90	31,57	,3168
36	,96842	—	229,85	322,95	6,90	30,96	,3107
100 + 35	,96901	—	236,42	329,51	6,91	30,35	,3045
34	,96960	—	243,37	336,48	6,89	29,72	,2982
33	,97021	—	250,75	343,89	6,86	29,08	,2918
32	,97081	—	258,58	351,75	6,83	28,43	,2853
31	,97141	—	266,92	360,11	6,81	27,77	,2787
100 + 30	,97202	—	275,82	369,05	6,77	27,10	,2719
29	,97263	—	285,33	378,60	6,73	26,41	,2650
28	,97326	—	295,52	388,83	6,69	25,72	,2581
27	,97389	—	306,47	399,82	6,65	25,01	,2509
26	,97454	—	318,25	411,66	6,59	24,29	,2437
100 + 25	,97518	—	330,99	424,46	6,53	23,56	,2364
24	,97584	—	344,78	438,30	6,48	22,81	,2289
23	,97652	—	359,76	453,36	6,40	22,06	,2213
22	,97720	—	376,11	469,78	6,33	21,29	,2135
21	,97791	—	394,03	487,77	6,26	20,50	,2057
100 + 20	,97862	—	413,73	507,56	6,17	19,70	,1977
19	,97935	—	435,51	529,42	6,09	18,89	,1895
18	,98010	—	459,71	553,71	6,00	18,06	,1812
17	,98088	—	486,75	580,86	5,89	17,22	,1727
16	,98168	—	517,17	611,38	5,79	16,36	,1641
100 + 15	,98250	—	551,64	645,98	5,66	15,48	,1553
14	,98335	—	591,05	685,51	5,54	14,59	,1463
13	,98423	—	636,52	731,11	5,41	13,68	,1372
12	,98516	—	689,56	784,30	5,26	12,75	,1279
11	,98611	—	752,25	847,13	5,12	11,81	,1184
100 + 10	,98711	—	827,47	922,49	4,98	10,84	,1088
9	,98815	—	919,42	1014,62	4,80	9,86	,0989
8	,98926	—	1034,34	1129,73	4,61	8,85	,0888
7	,99042	—	1182,10	1277,67	4,43	7,83	,0785
6	,99163	—	1379,12	1474,86	4,26	6,78	,0680
100 + 5	,99291	—	1654,95	1750,89	4,06	5,71	,0573
4	,99425	—	2068,67	2164,83	3,84	4,62	,0463
3	,99568	—	2758,23	2854,58	3,65	3,50	,0351
2	,99719	—	4137,35	4233,89	3,46	2,36	,0237
1	,99878	—	8274,71	8371,43	3,28	1,19	,0120

TABLE I. HEAT 55°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82736	100	—	100,00	—	100,00	1,0029
1	,82967	—	0,83	100,72	0,11	99,29	,9957
2	,83192	—	1,65	101,44	0,21	98,58	,9886
3	,83412	—	2,48	102,16	0,32	97,88	,9816
4	,83626	—	3,31	102,89	0,42	97,19	,9747
100 + 5	,83834	—	4,13	103,62	0,51	96,50	,9678
6	,84037	—	4,96	104,36	0,60	95,82	,9610
7	,84235	—	5,79	105,10	0,69	95,15	,9543
8	,84429	—	6,62	105,84	0,78	94,49	,9476
9	,84618	—	7,44	106,58	0,86	93,83	,9410
100 + 10	,84802	—	8,27	107,32	0,95	93,18	,9345
11	,84982	—	9,10	108,07	1,03	92,54	,9280
12	,85158	—	9,92	108,81	1,11	91,90	,9216
13	,85330	—	10,75	109,56	1,19	91,27	,9153
14	,85499	—	11,58	110,32	1,26	90,65	,9091
100 + 15	,85664	—	12,41	111,07	1,34	90,03	,9029
16	,85825	—	13,23	111,82	1,41	89,43	,8968
17	,85984	—	14,06	112,58	1,48	88,83	,8908
18	,86139	—	14,89	113,34	1,55	88,23	,8848
19	,86292	—	15,71	114,09	1,62	87,64	,8789
100 + 20	,86441	—	16,54	114,86	1,68	87,06	,8731
21	,86588	—	17,37	115,62	1,75	86,49	,8674
22	,86732	—	18,19	116,38	1,81	85,93	,8617
23	,86874	—	19,02	117,14	1,88	85,37	,8561
24	,87013	—	19,85	117,90	1,95	84,82	,8506
100 + 25	,87150	—	20,68	118,67	2,01	84,27	,8451
26	,87284	—	21,50	119,43	2,07	83,73	,8397
27	,87415	—	22,33	120,20	2,13	83,19	,8343
28	,87544	—	23,16	120,97	2,19	82,66	,8290
29	,87671	—	23,98	121,74	2,24	82,14	,8238
100 + 30	,87796	—	24,81	122,51	2,30	81,63	,8186
31	,87919	—	25,64	123,28	2,36	81,12	,8135
32	,88040	—	26,46	124,05	2,41	80,62	,8084
33	,88160	—	27,29	124,82	2,47	80,12	,8034
34	,88277	—	28,12	125,59	2,53	79,63	,7985
100 + 35	,88393	—	28,95	126,36	2,59	79,14	,7936
36	,88507	—	29,77	127,13	2,64	78,66	,7888
37	,88619	—	30,60	127,90	2,70	78,18	,7840
38	,88729	—	31,43	128,68	2,75	77,71	,7793
39	,88838	—	32,25	129,45	2,80	77,25	,7747
100 + 40	,88945	—	33,08	130,23	2,85	76,79	,7701
41	,89051	—	33,91	131,00	2,91	76,33	,7655
42	,89155	—	34,74	131,77	2,97	75,88	,7610
43	,89258	—	35,56	132,55	3,01	75,44	,7566
44	,89359	—	36,39	133,33	3,06	75,00	,7522
100 + 45	,89458	—	37,22	134,11	3,11	74,57	,7478
46	,89556	—	38,04	134,88	3,16	74,14	,7435
47	,89653	—	38,87	135,66	3,21	73,71	,7392
48	,89748	—	39,70	136,44	3,26	73,29	,7350
49	,89841	—	40,52	137,22	3,30	72,88	,7308

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89933	100	41,35	138,00	3,35	72,47	,7267
51	,90023	—	42,18	138,78	3,40	72,06	,7226
52	,90111	—	43,01	139,56	3,45	71,65	,7186
53	,90198	—	43,83	140,34	3,49	71,25	,7146
54	,90283	—	44,66	141,13	3,53	70,86	,7106
100 + 55	,90367	—	45,49	141,91	3,58	70,47	,7067
56	,90450	—	46,31	142,70	3,61	70,08	,7028
57	,90531	—	47,14	143,48	3,66	69,69	,6989
58	,90611	—	47,97	144,27	3,70	69,31	,6951
59	,90690	—	48,79	145,05	3,74	68,94	,6913
100 + 60	,90768	—	49,62	145,84	3,78	68,57	,6876
61	,90845	—	50,45	146,63	3,82	68,20	,6839
62	,90921	—	51,28	147,42	3,86	67,83	,6803
63	,90996	—	52,10	148,20	3,90	67,48	,6767
64	,91070	—	52,93	148,99	3,94	67,12	,6731
100 + 65	,91144	—	53,76	149,78	3,98	66,77	,6696
66	,91217	—	54,58	150,57	4,01	66,42	,6661
67	,91289	—	55,41	151,35	4,06	66,07	,6626
68	,91361	—	56,24	152,14	4,10	65,73	,6592
69	,91432	—	57,07	152,93	4,14	65,39	,6558
100 + 70	,91502	—	57,89	153,71	4,18	65,06	,6524
71	,91571	—	58,72	154,50	4,22	64,73	,6491
72	,91639	—	59,55	155,29	4,26	64,40	,6458
73	,91706	—	60,37	156,08	4,29	64,07	,6425
74	,91772	—	61,20	156,87	4,33	63,75	,6393
100 + 75	,91837	—	62,03	157,66	4,37	63,43	,6361
76	,91901	—	62,85	158,45	4,40	63,11	,6329
77	,91963	—	63,68	159,24	4,44	62,80	,6298
78	,92024	—	64,51	160,04	4,47	62,49	,6267
79	,92085	—	65,34	160,83	4,51	62,18	,6236
100 + 80	,92145	—	66,16	161,62	4,54	61,87	,6205
81	,92205	—	66,99	162,42	4,57	61,57	,6175
82	,92264	—	67,82	163,21	4,61	61,27	,6145
83	,92322	—	68,64	164,00	4,64	60,97	,6115
84	,92379	—	69,47	164,79	4,68	60,68	,6085
100 + 85	,92436	—	70,30	165,59	4,71	60,39	,6056
86	,92492	—	71,13	166,38	4,75	60,10	,6027
87	,92547	—	71,95	167,18	4,77	59,82	,5998
88	,92601	—	72,78	167,97	4,81	59,53	,5970
89	,92654	—	73,61	168,77	4,84	59,25	,5942
100 + 90	,92707	—	74,43	169,56	4,87	58,97	,5914
91	,92759	—	75,26	170,36	4,90	58,70	,5886
92	,92811	—	76,09	171,16	4,93	58,43	,5859
93	,92862	—	76,91	171,96	4,95	58,16	,5832
94	,92913	—	77,74	172,75	4,99	57,89	,5805
100 + 95	,92963	—	78,57	173,55	5,02	57,62	,5779
96	,93012	—	79,39	174,34	5,05	57,36	,5752
97	,93062	—	80,21	175,13	5,08	57,10	,5727
98	,93111	—	81,04	175,92	5,12	56,84	,5701
99	,93159	—	81,87	176,72	5,15	56,59	,5675

TABLE II. HEAT 55°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93208	100	82,70	177,53	5,17	56,33	,5649
99	,93257	—	83,55	178,34	5,21	56,07	,5623
98	,93306	—	84,40	179,17	5,23	55,81	,5597
97	,93354	—	85,27	180,02	5,25	55,55	,5571
96	,93403	—	86,16	180,87	5,29	55,29	,5545
100 + 95	,93452	—	87,06	181,74	5,32	55,03	,5518
94	,93500	—	87,98	182,64	5,34	54,76	,5491
93	,93549	—	88,92	183,55	5,37	54,48	,5464
92	,93598	—	89,89	184,48	5,41	54,21	,5436
91	,93647	—	90,88	185,44	5,44	53,93	,5408
100 + 90	,93696	—	91,89	186,42	5,47	53,64	,5380
89	,93746	—	92,92	187,42	5,50	53,35	,5351
88	,93796	—	93,98	188,44	5,54	53,06	,5322
87	,93846	—	95,06	189,49	5,57	52,77	,5292
86	,93897	—	96,17	190,57	5,60	52,47	,5262
100 + 85	,93948	—	97,30	191,67	5,63	52,17	,5232
84	,94000	—	98,45	192,80	5,65	51,87	,5202
83	,94052	—	99,64	193,95	5,69	51,56	,5171
82	,94105	—	100,86	195,13	5,73	51,25	,5139
81	,94159	—	102,10	196,35	5,75	50,93	,5107
100 + 80	,94213	—	103,38	197,59	5,79	50,61	,5075
79	,94267	—	104,69	198,86	5,83	50,29	,5043
78	,94321	—	106,03	200,17	5,86	49,96	,5010
77	,94376	—	107,41	201,52	5,89	49,62	,4977
76	,94431	—	108,82	202,90	5,92	49,29	,4943
100 + 75	,94486	—	110,27	204,32	5,95	48,94	,4908
74	,94542	—	111,76	205,77	5,99	48,60	,4874
73	,94598	—	113,29	207,27	6,02	48,25	,4839
72	,94654	—	114,86	208,81	6,05	47,89	,4803
71	,94710	—	116,48	210,40	6,08	47,53	,4767
100 + 70	,94767	—	118,15	212,03	6,12	47,16	,4730
69	,94824	—	119,86	213,70	6,16	46,79	,4693
68	,94882	—	121,62	215,43	6,19	46,42	,4655
67	,94940	—	123,44	217,21	6,23	46,04	,4617
66	,94998	—	125,31	219,05	6,26	45,65	,4578
100 + 65	,95057	—	127,24	220,94	6,30	45,26	,4539
64	,95116	—	129,22	222,89	6,33	44,86	,4499
63	,95176	—	131,27	224,90	6,37	44,46	,4459
62	,95236	—	133,39	226,99	6,40	44,05	,4418
61	,95296	—	135,58	229,15	6,43	43,64	,4376
100 + 60	,95357	—	137,84	231,37	6,47	43,22	,4334
59	,95418	—	140,17	233,67	6,50	42,79	,4292
58	,95479	—	142,58	236,05	6,53	42,36	,4249
57	,95540	—	145,09	238,52	6,57	41,92	,4205
56	,95601	—	147,69	241,09	6,60	41,48	,4160
100 + 55	,95662	—	150,37	243,74	6,63	41,03	,4114
54	,95723	—	153,13	246,48	6,65	40,57	,4068
53	,95784	—	156,01	249,34	6,67	40,10	,4022
52	,95844	—	159,02	252,32	6,70	39,63	,3975
51	,95905	—	162,15	255,42	6,73	39,15	,3926

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95966	100	165,41	258,64	6,77	38,66	,3877
49	,96027	—	168,79	262,03	6,76	38,16	,3828
48	,96088	—	172,30	265,49	6,81	37,66	,3777
47	,96150	—	175,96	269,13	6,83	37,16	,3726
46	,96211	—	179,79	272,94	6,85	36,64	,3674
100 + 45	,96272	—	183,79	276,92	6,87	36,11	,3622
44	,96333	—	187,96	281,08	6,88	35,58	,3568
43	,96393	—	192,33	285,44	6,89	35,03	,3513
42	,96454	—	196,91	290,01	6,90	34,48	,3458
41	,96515	—	201,72	294,80	6,92	33,92	,3402
100 + 40	,96575	—	206,76	299,85	6,91	33,35	,3345
39	,96635	—	212,06	305,16	6,90	32,77	,3286
38	,96696	—	217,64	310,74	6,90	32,18	,3227
37	,96756	—	223,53	316,64	6,89	31,58	,3167
36	,96817	—	229,73	322,86	6,87	30,97	,3106
100 + 35	,96877	—	236,30	329,41	6,89	30,36	,3044
34	,96937	—	243,25	336,37	6,88	29,73	,2981
33	,96998	—	250,62	343,77	6,85	29,09	,2917
32	,97059	—	258,45	351,63	6,82	28,44	,2852
31	,97120	—	266,79	359,98	6,81	27,78	,2786
100 + 30	,97181	—	275,68	368,92	6,76	27,11	,2718
29	,97243	—	285,19	378,46	6,73	26,42	,2650
28	,97306	—	295,37	388,68	6,69	25,73	,2580
27	,97370	—	306,31	399,66	6,65	25,02	,2509
26	,97435	—	318,09	411,49	6,60	24,30	,2437
100 + 25	,97500	—	330,82	424,29	6,53	23,57	,2364
24	,97567	—	344,60	438,13	6,47	22,82	,2289
23	,97635	—	359,58	453,18	6,40	22,06	,2213
22	,97704	—	375,92	469,59	6,33	21,29	,2135
21	,97775	—	393,83	487,57	6,26	20,51	,2057
100 + 20	,97847	—	413,52	507,34	6,18	19,71	,1977
19	,97921	—	435,29	529,19	6,10	18,90	,1895
18	,97997	—	459,47	553,47	6,00	18,07	,1812
17	,98075	—	486,50	580,60	5,90	17,22	,1727
16	,98156	—	516,90	611,10	5,80	16,36	,1641
100 + 15	,98239	—	551,36	645,68	5,68	15,49	,1553
14	,98324	—	590,75	685,19	5,56	14,59	,1463
13	,98413	—	636,19	730,76	5,43	13,68	,1372
12	,98506	—	689,20	783,92	5,28	12,75	,1279
11	,98602	—	751,86	846,72	5,14	11,81	,1184
100 + 10	,98702	—	827,04	922,04	5,00	10,85	,1088
9	,98807	—	918,94	1014,12	4,82	9,86	,0989
8	,98918	—	1033,80	1129,16	4,64	8,85	,0888
7	,99034	—	1181,49	1277,02	4,47	7,83	,0785
6	,99156	—	1378,41	1474,11	4,30	6,78	,0680
100 + 5	,99284	—	1654,09	1749,99	4,10	5,71	,0573
4	,99419	—	2067,61	2163,71	3,90	4,62	,0463
3	,99562	—	2756,81	2853,11	3,70	3,50	,0351
2	,99712	—	4135,22	4231,71	3,51	2,36	,0237
1	,99871	—	8270,45	8367,12	3,33	1,19	,0120

TABLE I. HEAT 56°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82689	100	—	100,00	—	100,00	1,0023
1	,82919	—	0,83	100,72	0,11	99,29	,9952
2	,83145	—	1,65	101,44	0,21	98,58	,9881
3	,83365	—	2,48	102,16	0,32	97,88	,9811
4	,83579	—	3,31	102,89	0,42	97,19	,9741
100 + 5	,83787	—	4,13	103,62	0,51	96,50	,9672
6	,83990	—	4,96	104,36	0,60	95,82	,9605
7	,84188	—	5,79	105,10	0,69	95,15	,9538
8	,84382	—	6,62	105,84	0,78	94,49	,9471
9	,84571	—	7,44	106,58	0,86	93,83	,9405
100 + 10	,84756	—	8,27	107,32	0,95	93,18	,9339
11	,84935	—	9,10	108,07	1,03	92,54	,9275
12	,85111	—	9,92	108,81	1,11	91,90	,9211
13	,85283	—	10,74	109,56	1,18	91,27	,9148
14	,85452	—	11,57	110,32	1,25	90,65	,9086
100 + 15	,85618	—	12,40	111,07	1,33	90,04	,9024
16	,85778	—	13,23	111,82	1,41	89,43	,8963
17	,85938	—	14,05	112,58	1,47	88,83	,8903
18	,86092	—	14,88	113,33	1,55	88,23	,8844
19	,86246	—	15,70	114,09	1,61	87,64	,8785
100 + 20	,86395	—	16,53	114,86	1,67	87,06	,8727
21	,86542	—	17,36	115,62	1,74	86,49	,8670
22	,86686	—	18,19	116,38	1,81	85,93	,8613
23	,86828	—	19,01	117,14	1,87	85,37	,8557
24	,86967	—	19,84	117,90	1,94	84,82	,8502
100 + 25	,87104	—	20,67	118,66	2,01	84,27	,8447
26	,87238	—	21,49	119,43	2,06	83,73	,8393
27	,87369	—	22,32	120,20	2,12	83,19	,8339
28	,87498	—	23,15	120,96	2,19	82,67	,8286
29	,87626	—	23,97	121,74	2,23	82,15	,8234
100 + 30	,87750	—	24,80	122,50	2,30	81,63	,8182
31	,87874	—	25,63	123,27	2,36	81,12	,8131
32	,87994	—	26,45	124,04	2,41	80,62	,8080
33	,88115	—	27,28	124,81	2,47	80,12	,8030
34	,88232	—	28,11	125,58	2,53	79,63	,7981
100 + 35	,88348	—	28,93	126,35	2,58	79,14	,7932
36	,88462	—	29,76	127,12	2,64	78,66	,7884
37	,88574	—	30,58	127,89	2,69	78,19	,7836
38	,88685	—	31,41	128,67	2,74	77,72	,7789
39	,88793	—	32,23	129,44	2,79	77,25	,7743
100 + 40	,88900	—	33,06	130,22	2,84	76,79	,7697
41	,89006	—	33,89	130,99	2,90	76,34	,7652
42	,89110	—	34,72	131,76	2,96	75,89	,7607
43	,89213	—	35,54	132,54	3,00	75,44	,7563
44	,89314	—	36,37	133,32	3,05	75,00	,7519
100 + 45	,89412	—	37,20	134,10	3,10	74,57	,7475
46	,89510	—	38,02	134,87	3,15	74,14	,7432
47	,89608	—	38,85	135,65	3,20	73,72	,7389
48	,89703	—	39,68	136,43	3,25	73,30	,7347
49	,89796	—	40,50	137,21	3,29	72,88	,7305

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89887	100	41,33	137,99	3,34	72,47	,7264
51	,89978	—	42,16	138,77	3,39	72,06	,7223
52	,90066	—	42,98	139,55	3,43	71,66	,7183
53	,90153	—	43,80	140,33	3,47	71,26	,7143
54	,90238	—	44,63	141,11	3,52	70,87	,7103
100 + 55	,90323	—	45,46	141,90	3,56	70,47	,7064
56	,90405	—	46,28	142,68	3,60	70,09	,7025
57	,90487	—	47,11	143,46	3,65	69,70	,6986
58	,90567	—	47,94	144,25	3,69	69,32	,6948
59	,90646	—	48,76	145,03	3,73	68,95	,6910
100 + 60	,90724	—	49,59	145,82	3,77	68,58	,6873
61	,90801	—	50,42	146,61	3,81	68,21	,6836
62	,90877	—	51,25	147,40	3,85	67,84	,6800
63	,90953	—	52,07	148,18	3,89	67,48	,6764
64	,91026	—	52,90	148,97	3,93	67,13	,6728
100 + 65	,91100	—	53,73	149,76	3,97	66,77	,6693
66	,91173	—	54,55	150,55	4,00	66,42	,6658
67	,91246	—	55,38	151,33	4,05	66,07	,6623
68	,91318	—	56,21	152,12	4,09	65,73	,6589
69	,91389	—	57,04	152,91	4,13	65,40	,6555
100 + 70	,91459	—	57,86	153,70	4,16	65,06	,6521
71	,91528	—	58,69	154,48	4,21	64,73	,6488
72	,91596	—	59,52	155,27	4,25	64,40	,6455
73	,91663	—	60,34	156,06	4,28	64,07	,6422
74	,91729	—	61,17	156,85	4,32	63,75	,6390
100 + 75	,91794	—	62,00	157,64	4,36	63,43	,6358
76	,91858	—	62,82	158,43	4,39	63,12	,6326
77	,91920	—	63,64	159,22	4,42	62,80	,6295
78	,91982	—	64,47	160,02	4,45	62,49	,6264
79	,92043	—	65,30	160,81	4,49	62,18	,6233
100 + 80	,92102	—	66,12	161,60	4,52	61,88	,6202
81	,92163	—	66,95	162,40	4,55	61,58	,6172
82	,92222	—	67,78	163,19	4,59	61,28	,6142
83	,92280	—	68,60	163,98	4,62	60,98	,6112
84	,92337	—	69,43	164,77	4,66	60,69	,6083
100 + 85	,92393	—	70,26	165,57	4,69	60,40	,6054
86	,92450	—	71,09	166,36	4,73	60,11	,6025
87	,92505	—	71,91	167,16	4,75	59,82	,5996
88	,92559	—	72,74	167,95	4,79	59,54	,5968
89	,92612	—	73,57	168,75	4,82	59,26	,5940
100 + 90	,92666	—	74,39	169,54	4,85	58,98	,5912
91	,92717	—	75,22	170,33	4,89	58,70	,5884
92	,92769	—	76,05	171,13	4,92	58,43	,5857
93	,92821	—	76,87	171,93	4,94	58,16	,5830
94	,92871	—	77,70	172,73	4,97	57,89	,5803
100 + 95	,92922	—	78,53	173,52	5,01	57,63	,5776
96	,92971	—	79,35	174,31	5,04	57,37	,5750
97	,93020	—	80,17	175,11	5,06	57,11	,5724
98	,93069	—	81,00	175,90	5,10	56,85	,5698
99	,93118	—	81,83	176,70	5,13	56,59	,5672

TABLE II. HEAT 56°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,93166	100	82,66	177,50	5,16	56,33	,5646	100 + 50	,95933	100	165,32	258,58	6,74	38,67	,3876
99	,93215	—	83,50	178,31	5,19	56,08	,5621	49	,95995	—	168,70	261,96	6,74	38,17	,3827
98	,93265	—	84,35	179,14	5,21	55,82	,5595	48	,96057	—	172,21	265,42	6,79	37,67	,3776
97	,93313	—	85,22	179,99	5,23	55,56	,5569	47	,96119	—	175,87	269,06	6,81	37,17	,3725
96	,93362	—	86,11	180,84	5,27	55,30	,5543	46	,96181	—	179,70	272,87	6,83	36,65	,3673
100 + 95	,93411	—	87,01	181,71	5,30	55,03	,5516	100 + 45	,96242	—	183,70	276,85	6,85	36,12	,3620
94	,93460	—	87,93	182,62	5,31	54,76	,5489	44	,96304	—	187,86	281,00	6,86	35,59	,3567
93	,93509	—	88,87	183,52	5,35	54,49	,5462	43	,96364	—	192,23	285,36	6,87	35,04	,3512
92	,93558	—	89,84	184,45	5,39	54,21	,5434	42	,96426	—	196,81	289,93	6,88	34,49	,3457
91	,93607	—	90,83	185,41	5,42	53,93	,5406	41	,96487	—	201,61	294,71	6,90	33,93	,3401
100 + 90	,93656	—	91,84	186,39	5,45	53,65	,5377	100 + 40	,96548	—	206,65	299,76	6,89	33,36	,3344
89	,93706	—	92,87	187,39	5,48	53,36	,5349	39	,96608	—	211,95	305,07	6,88	32,78	,3285
88	,93756	—	93,93	188,41	5,52	53,07	,5320	38	,96670	—	217,53	310,64	6,89	32,19	,3226
87	,93806	—	95,01	189,47	5,54	52,78	,5290	37	,96730	—	223,41	316,55	6,86	31,59	,3166
86	,93857	—	96,12	190,54	5,58	52,48	,5260	36	,96792	—	229,61	322,76	6,85	30,98	,3105
100 + 85	,93909	—	97,25	191,65	5,60	52,18	,5230	100 + 35	,96852	—	236,18	329,31	6,87	30,37	,3044
84	,93960	—	98,40	192,77	5,63	51,88	,5200	34	,96913	—	243,13	336,26	6,87	29,74	,2981
83	,94013	—	99,59	193,92	5,67	51,57	,5169	33	,96975	—	250,49	343,65	6,84	29,10	,2917
82	,94065	—	100,81	195,10	5,71	51,26	,5137	32	,97036	—	258,32	351,51	6,81	28,45	,2852
81	,94120	—	102,05	196,32	5,73	50,94	,5105	31	,97098	—	266,65	359,86	6,79	27,79	,2786
100 + 80	,94174	—	103,32	197,56	5,70	50,61	,5073	100 + 30	,97160	—	275,54	368,79	6,75	27,11	,2718
79	,94228	—	104,63	198,83	5,80	50,29	,5040	29	,97223	—	285,04	378,32	6,72	26,43	,2649
78	,94282	—	105,97	200,14	5,83	49,96	,5008	28	,97286	—	295,22	388,54	6,68	25,74	,2580
77	,94337	—	107,35	201,49	5,86	49,63	,4975	27	,97351	—	306,16	399,51	6,65	25,03	,2509
76	,94392	—	108,76	202,86	5,90	49,30	,4941	26	,97416	—	317,93	411,34	6,59	24,31	,2437
100 + 75	,94448	—	110,21	204,29	5,92	48,95	,4906	100 + 25	,97482	—	330,65	424,12	6,53	23,58	,2363
74	,94504	—	111,70	205,74	5,96	48,60	,4872	24	,97550	—	344,43	437,96	6,47	22,83	,2289
73	,94560	—	113,23	207,24	5,99	48,25	,4837	23	,97618	—	359,40	453,00	6,40	22,07	,2213
72	,94617	—	114,80	208,77	6,03	47,90	,4801	22	,97688	—	375,73	469,40	6,33	21,30	,2135
71	,94672	—	116,42	210,37	6,05	47,54	,4765	21	,97760	—	393,63	487,37	6,26	20,51	,2056
100 + 70	,94729	—	118,09	212,00	6,09	47,17	,4728	100 + 20	,97831	—	413,31	507,13	6,18	19,72	,1976
69	,94787	—	119,80	213,66	6,14	46,80	,4691	19	,97907	—	435,07	528,97	6,10	18,90	,1895
68	,94845	—	121,56	215,39	6,17	46,43	,4654	18	,97983	—	459,24	553,23	6,01	18,07	,1812
67	,94903	—	123,37	217,17	6,20	46,05	,4616	17	,98062	—	486,25	580,34	5,91	17,23	,1727
66	,94962	—	125,24	219,01	6,23	45,66	,4577	16	,98143	—	516,64	610,83	5,81	16,37	,1641
100 + 65	,95020	—	127,17	220,90	6,27	45,27	,4537	100 + 15	,98227	—	551,08	645,39	5,69	15,49	,1553
64	,95080	—	129,15	222,85	6,30	44,87	,4497	14	,98312	—	590,45	684,88	5,57	14,60	,1463
63	,95140	—	131,20	224,86	6,34	44,46	,4457	13	,98402	—	635,87	730,42	5,45	13,69	,1372
62	,95201	—	133,32	226,94	6,38	44,06	,4416	12	,98496	—	688,86	783,55	5,31	12,76	,1279
61	,95261	—	135,51	229,10	6,41	43,65	,4375	11	,98592	—	751,48	846,32	5,16	11,82	,1184
100 + 60	,95322	—	137,77	231,34	6,43	43,23	,4333	100 + 10	,98693	—	820,63	921,60	5,03	10,85	,1087
59	,95383	—	140,10	233,63	6,47	42,80	,4291	9	,98798	—	918,48	1013,63	4,85	9,86	,0989
58	,95445	—	142,51	236,01	6,50	42,37	,4248	8	,98909	—	1033,29	1128,61	4,68	8,86	,0888
57	,95506	—	145,01	238,47	6,54	41,93	,4204	7	,99026	—	1180,90	1276,40	4,50	7,83	,0785
56	,95567	—	147,61	241,03	6,58	41,49	,4159	6	,99148	—	1377,72	1473,38	4,34	6,79	,0680
100 + 55	,95629	—	150,29	243,68	6,61	41,04	,4113	100 + 5	,99276	—	1653,27	1749,13	4,14	5,72	,0573
54	,95690	—	153,05	246,42	6,63	40,58	,4067	4	,99412	—	2066,57	2162,63	3,94	4,62	,0464
53	,95751	—	155,93	249,29	6,64	40,11	,4021	3	,99555	—	2755,42	2851,67	3,75	3,50	,0352
52	,95811	—	158,94	252,26	6,68	39,64	,3974	2	,99705	—	4133,14	4229,57	3,57	2,36	,0237
51	,95873	—	162,07	255,37	6,70	39,16	,3925	1	,99864	—	8266,29	8363,90	3,39	1,20	,0120

TABLE I. HEAT 57°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82642	100	—	100,00	—	100,00	1,0017
1	,82872	—	0,83	100,72	0,11	99,29	,9947
2	,83098	—	1,65	101,44	0,21	98,58	,9876
3	,83318	—	2,48	102,16	0,32	97,88	,9806
4	,83532	—	3,31	102,89	0,42	97,19	,9736
100 + 5	,83740	—	4,13	103,62	0,51	96,50	,9667
6	,83943	—	4,96	104,36	0,60	95,82	,9600
7	,84141	—	5,78	105,10	0,68	95,16	,9533
8	,84335	—	6,61	105,84	0,77	94,49	,9466
9	,84524	—	7,43	106,58	0,85	93,83	,9400
100 + 10	,84709	—	8,26	107,32	0,94	93,18	,9334
11	,84888	—	9,09	108,06	1,03	92,54	,9270
12	,85064	—	9,91	108,81	1,10	91,90	,9206
13	,85236	—	10,74	109,56	1,18	91,27	,9143
14	,85405	—	11,57	110,31	1,26	90,65	,9081
100 + 15	,85571	—	12,39	111,07	1,32	90,04	,9019
16	,85732	—	13,22	111,82	1,40	89,43	,8959
17	,85891	—	14,04	112,57	1,47	88,83	,8899
18	,86046	—	14,87	113,33	1,54	88,24	,8839
19	,86199	—	15,69	114,09	1,60	87,65	,8780
100 + 20	,86348	—	16,52	114,85	1,67	87,07	,8722
21	,86496	—	17,35	115,61	1,74	86,50	,8665
22	,86640	—	18,18	116,37	1,81	85,93	,8608
23	,86782	—	19,00	117,13	1,87	85,37	,8552
24	,86920	—	19,83	117,89	1,94	84,82	,8497
100 + 25	,87057	—	20,66	118,66	2,00	84,27	,8442
26	,87191	—	21,48	119,42	2,06	83,73	,8388
27	,87323	—	22,31	120,19	2,12	83,20	,8334
28	,87452	—	23,14	120,96	2,18	82,67	,8281
29	,87580	—	23,96	121,73	2,23	82,15	,8229
100 + 30	,87705	—	24,79	122,50	2,29	81,64	,8177
31	,87829	—	25,61	123,26	2,35	81,13	,8126
32	,87949	—	26,44	124,03	2,41	80,63	,8076
33	,88070	—	27,27	124,80	2,47	80,13	,8026
34	,88187	—	28,09	125,57	2,52	79,64	,7977
100 + 35	,88304	—	28,92	126,35	2,57	79,15	,7928
36	,88417	—	29,74	127,11	2,63	78,67	,7880
37	,88530	—	30,57	127,88	2,69	78,19	,7833
38	,88640	—	31,40	128,66	2,74	77,72	,7786
39	,88748	—	32,22	129,43	2,79	77,26	,7739
100 + 40	,88855	—	33,05	130,21	2,84	76,80	,7693
41	,88960	—	33,87	130,98	2,89	76,34	,7648
42	,89065	—	34,70	131,76	2,94	75,89	,7603
43	,89168	—	35,52	132,53	2,99	75,45	,7559
44	,89269	—	36,35	133,31	3,04	75,01	,7515
100 + 45	,89367	—	37,18	134,09	3,09	74,58	,7471
46	,89465	—	38,00	134,86	3,14	74,15	,7428
47	,89563	—	38,83	135,64	3,19	73,72	,7385
48	,89658	—	39,66	136,42	3,24	73,30	,7343
49	,89751	—	40,48	137,20	3,28	72,88	,7301

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89842	100	41,31	137,98	3,33	72,48	,7260
51	,89933	—	42,13	138,76	3,37	72,07	,7219
52	,90021	—	42,96	139,54	3,42	71,66	,7179
53	,90108	—	43,78	140,32	3,46	71,26	,7139
54	,90194	—	44,61	141,10	3,51	70,87	,7100
100 + 55	,90279	—	45,44	141,89	3,55	70,48	,7060
56	,90361	—	46,26	142,67	3,59	70,09	,7021
57	,90442	—	47,09	143,45	3,64	69,70	,6982
58	,90523	—	47,91	144,24	3,67	69,32	,6945
59	,90602	—	48,74	145,02	3,72	68,95	,6907
100 + 60	,90681	—	49,57	145,81	3,76	68,59	,6870
61	,90758	—	50,40	146,60	3,80	68,22	,6833
62	,90834	—	51,23	147,39	3,84	67,85	,6797
63	,90910	—	52,05	148,17	3,88	67,49	,6761
64	,90983	—	52,88	148,96	3,92	67,13	,6724
100 + 65	,91056	—	53,70	149,75	3,95	66,78	,6689
66	,91130	—	54,53	150,54	3,99	66,43	,6655
67	,91203	—	55,35	151,32	4,03	66,08	,6620
68	,91275	—	56,18	152,11	4,07	65,74	,6586
69	,91346	—	57,01	152.90	4,11	65,40	,6552
100 + 70	,91416	—	57,83	153,68	4,15	65,07	,6518
71	,91485	—	58,66	154,47	4,19	64,74	,6485
72	,91553	—	59,49	155,26	4,23	64,41	,6452
73	,91620	—	60,31	156,05	4,26	64,08	,6419
74	,91686	—	61,14	156,84	4,30	63,76	,6387
100 + 75	,91751	—	61,96	157,63	4,33	63,44	,6355
76	,91815	—	62,79	158,42	4,37	63,13	,6323
77	,91877	—	63,61	159,21	4,40	62,81	,6292
78	,91940	—	64,44	160,00	4,44	62,50	,6261
79	,92001	—	65,27	160,79	4,48	62,19	,6230
100 + 80	,92059	—	66,09	161,58	4,51	61,89	,6199
81	,92120	—	66,92	162,38	4,54	61,59	,6169
82	,92180	—	67,75	163,17	4,58	61,29	,6139
83	,92237	—	68,57	163,96	4,61	60,99	,6110
84	,92294	—	69,40	164,75	4,65	60,70	,6081
100 + 85	,92351	—	70,23	165,55	4,68	60,41	,6051
86	,92408	—	71,06	166,34	4,72	60,12	,6022
87	,92463	—	71,88	167,14	4,74	59,83	,5993
88	,92517	—	72,71	167,93	4,78	59,55	,5965
89	,92571	—	73,53	168,73	4,80	59,27	,5937
100 + 90	,92625	—	74,36	169,52	4,84	58,99	,5909
91	,92676	—	75,18	170,31	4,87	58,71	,5881
92	,92728	—	76,01	171,11	4,90	58,44	,5854
93	,92780	—	76,83	171,91	4,92	58,17	,5827
94	,92830	—	77,66	172,70	4,96	57,90	,5800
100 + 95	,92881	—	78,49	173,50	4,99	57,63	,5774
96	,92930	—	79,31	174,29	5,02	57,38	,5748
97	,92979	—	80,13	175,09	5,04	57,12	,5722
98	,93028	—	80,96	175,88	5,08	56,86	,5696
99	,93077	—	81,79	176,68	5,11	56,60	,5670

TABLE II. HEAT 57°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,93125	100	82,62	177,48	5,14	56,34	,5644
99	,93174	—	83,46	178,29	5,17	56,08	,5618
98	,93224	—	84,31	179,12	5,19	55,83	,5592
97	,93272	—	85,17	179,97	5,20	55,57	,5566
96	,93321	—	86,07	180,82	5,25	55,31	,5540
100 + 95	,93370	—	86,97	181,69	5,28	55,04	,5514
94	,93419	—	87,89	182,59	5,30	54,77	,5486
93	,93468	—	88,83	183,50	5,33	54,50	,5459
92	,93517	—	89,79	184,43	5,36	54,22	,5432
91	,93566	—	90,78	185,39	5,39	53,94	,5403
100 + 90	,93616	—	91,79	186,37	5,42	53,65	,5375
89	,93665	—	92,83	187,37	5,46	53,37	,5346
88	,93716	—	93,89	188,39	5,50	53,08	,5317
87	,93766	—	94,97	189,44	5,53	52,78	,5288
86	,93817	—	96,07	190,51	5,56	52,48	,5258
100 + 85	,93869	—	97,20	191,62	5,58	52,18	,5228
84	,93921	—	98,35	192,74	5,61	51,89	,5198
83	,93973	—	99,54	193,89	5,65	51,58	,5167
82	,94026	—	100,76	195,08	5,68	51,27	,5135
81	,94081	—	102,00	196,29	5,71	50,95	,5103
100 + 80	,94135	—	103,27	197,53	5,74	50,62	,5071
79	,94190	—	104,58	198,80	5,78	50,30	,5038
78	,94244	—	105,92	200,10	5,82	49,97	,5006
77	,94299	—	107,30	201,45	5,85	49,63	,4973
76	,94354	—	108,71	202,83	5,88	49,30	,4939
100 + 75	,94410	—	110,16	204,25	5,91	48,96	,4904
74	,94466	—	111,64	205,70	5,94	48,61	,4870
73	,94522	—	113,17	207,20	5,97	48,26	,4835
72	,94579	—	114,75	208,74	6,01	47,90	,4799
71	,94635	—	116,36	210,33	6,03	47,55	,4763
100 + 70	,94691	—	118,03	211,96	6,07	47,18	,4726
69	,94750	—	119,74	213,62	6,12	46,81	,4689
68	,94808	—	121,50	215,35	6,15	46,43	,4652
67	,94865	—	123,31	217,14	6,17	46,05	,4614
66	,94925	—	125,18	218,97	6,21	45,66	,4575
100 + 65	,94984	—	127,10	220,86	6,24	45,28	,4535
64	,95044	—	129,09	222,81	6,28	44,88	,4496
63	,95105	—	131,13	224,82	6,31	44,47	,4456
62	,95165	—	133,25	226,90	6,35	44,07	,4415
61	,95225	—	135,45	229,06	6,39	43,66	,4373
100 + 60	,95287	—	137,70	231,29	6,41	43,24	,4331
59	,95348	—	140,03	233,58	6,45	42,81	,4289
58	,95410	—	142,44	235,96	6,48	42,38	,4246
57	,95471	—	144,94	238,42	6,52	41,94	,4202
56	,95533	—	147,54	240,97	6,57	41,49	,4157
100 + 55	,95595	—	150,21	243,62	6,59	41,04	,4112
54	,95656	—	152,98	246,37	6,61	40,58	,4065
53	,95717	—	155,86	249,24	6,62	40,12	,4019
52	,95778	—	158,86	252,20	6,66	39,64	,3972
51	,95840	—	162,00	255,31	6,69	39,16	,3924

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95900	100	165,24	258,52	6,72	38,68	,3875
49	,95963	—	168,61	261,89	6,72	38,18	,3825
48	,96025	—	172,12	265,35	6,77	37,68	,3775
47	,96088	—	175,78	268,99	6,79	37,17	,3724
46	,96150	—	179,61	272,80	6,81	36,65	,3672
100 + 45	,96212	—	183,61	276,78	6,83	36,13	,3619
44	,96274	—	187,77	280,92	6,85	35,60	,3566
43	,96335	—	192,13	285,28	6,85	35,05	,3511
42	,96397	—	196,71	289,84	6,87	34,50	,3456
41	,96459	—	201,51	294,63	6,88	33,94	,3400
100 + 40	,96521	—	206,55	299,68	6,87	33,37	,3343
39	,96581	—	211,84	304,98	6,86	32,79	,3285
38	,96643	—	217,42	310,55	6,87	32,20	,3225
37	,96704	—	223,30	316,45	6,85	31,60	,3165
36	,96766	—	229,50	322,66	6,84	30,99	,3104
100 + 35	,96827	—	236,06	329,21	6,85	30,38	,3043
34	,96889	—	243,01	336,15	6,86	29,75	,2980
33	,96951	—	250,36	343,54	6,82	29,11	,2916
32	,97013	—	258,19	351,39	6,80	28,46	,2851
31	,97076	—	266,52	359,74	6,78	27,80	,2785
100 + 30	,97138	—	275,40	368,66	6,74	27,12	,2717
29	,97202	—	284,90	378,18	6,72	26,44	,2649
28	,97266	—	295,07	388,40	6,67	25,75	,2579
27	,97331	—	306,01	399,37	6,64	25,04	,2508
26	,97397	—	317,77	411,19	6,58	24,32	,2436
100 + 25	,97464	—	330,48	423,96	6,52	23,59	,2363
24	,97532	—	344,26	437,79	6,47	22,84	,2288
23	,97601	—	359,22	452,82	6,40	22,08	,2212
22	,97671	—	375,54	469,21	6,33	21,31	,2135
21	,97744	—	393,43	487,17	6,26	20,52	,2056
100 + 20	,97816	—	413,10	506,92	6,18	19,72	,1976
19	,97892	—	434,85	528,75	6,10	18,91	,1895
18	,97969	—	459,01	552,99	6,02	18,08	,1812
17	,98048	—	486,01	580,09	5,92	17,24	,1727
16	,98130	—	516,38	610,56	5,82	16,38	,1641
100 + 15	,98215	—	550,81	645,10	5,71	15,50	,1553
14	,98300	—	590,16	684,57	5,59	14,61	,1463
13	,98390	—	635,55	730,09	5,46	13,69	,1372
12	,98485	—	688,52	783,19	5,33	12,77	,1279
11	,98582	—	751,11	845,92	5,19	11,82	,1184
100 + 10	,98684	—	826,22	921,16	5,06	10,85	,1087
9	,98789	—	918,02	1013,14	4,88	9,87	,0989
8	,98900	—	1032,78	1128,06	4,72	8,86	,0888
7	,99017	—	1180,31	1275,78	4,53	7,84	,0785
6	,99140	—	1377,04	1472,66	4,38	6,79	,0680
100 + 5	,99268	—	1652,45	1748,27	4,18	5,72	,0573
4	99404	—	2065,54	2161,56	3,98	4,63	,0463
3	,99548	—	2754,04	2850,24	3,80	3,51	,0351
2	,99698	—	4131,07	4227,44	3,63	2,37	,0237
1	,99857	—	8262,16	8358,71	3,45	1,20	,0120

TABLE I. HEAT 58°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82594	100	—	100,00	—	100,00	1,0011
1	,82825	—	0,83	100,72	0,11	99,29	,9941
2	,83051	—	1,65	101,44	0,21	98,58	,9871
3	,83271	—	2,48	102,16	0,32	97,88	,9801
4	,83485	—	3,31	102,89	0,42	97,19	,9731
100 + 5	,83693	—	4,13	103,63	0,51	96,50	,9662
6	,83896	—	4,96	104,36	0,60	95,82	,9595
7	,84094	—	5,78	105,10	0,68	95,16	,9528
8	,84289	—	6,61	105,84	0,77	94,49	,9461
9	,84477	—	7,43	106,58	0,85	93,83	,9395
100 + 10	,84662	—	8,26	107,32	0,94	93,18	,9329
11	,84842	—	9,09	108,06	1,03	92,54	,9265
12	,85017	—	9,91	108,81	1,10	91,90	,9201
13	,85189	—	10,73	109,56	1,17	91,27	,9138
14	,85359	—	11,56	110,31	1,25	90,65	,9076
100 + 15	,85524	—	12,39	111,06	1,33	90,04	,9014
16	,85685	—	13,21	111,82	1,39	89,43	,8954
17	,85844	—	14,04	112,57	1,47	88,83	,8894
18	,85999	—	14,87	113,33	1,54	88,24	,8835
19	,86152	—	15,68	114,09	1,59	87,65	,8776
100 + 20	,86302	—	16,51	114,85	1,66	87,07	,8717
21	,86449	—	17,34	115,61	1,73	86,50	,8660
22	,86593	—	18,17	116,37	1,80	85,93	,8604
23	,86735	—	18,99	117,13	1,86	85,37	,8548
24	,86874	—	19,82	117,89	1,93	84,82	,8493
100 + 25	,87011	—	20,64	118,65	1,99	84,27	,8438
26	,87145	—	21,47	119,42	2,05	83,73	,8384
27	,87276	—	22,30	120,19	2,11	83,20	,8330
28	,87406	—	23,13	120,95	2,18	82,67	,8277
29	,87534	—	23,94	121,73	2,21	82,15	,8225
100 + 30	,87659	—	24,78	122,49	2,29	81,64	,8173
31	,87784	—	25,60	123,26	2,34	81,13	,8122
32	,87904	—	26,42	124,03	2,39	80,63	,8072
33	,88025	—	27,25	124,80	2,45	80,13	,8022
34	,88143	—	28,08	125,57	2,51	79,64	,7973
100 + 35	,88259	—	28,91	126,34	2,57	79,15	,7924
36	,88373	—	29,73	127,10	2,63	78,67	,7876
37	,88485	—	30,55	127,88	2,67	78,20	,7829
38	,88595	—	31,38	128,66	2,72	77,73	,7782
39	,88703	—	32,20	129,42	2,78	77,26	,7735
100 + 40	,88810	—	33,03	130,21	2,82	76,80	,7689
41	,88915	—	33,86	130,97	2,89	76,35	,7644
42	,89020	—	34,69	131,75	2,94	75,90	,7599
43	,89123	—	35,51	132,52	2,99	75,45	,7555
44	,89224	—	36,34	133,31	3,03	75,01	,7511
100 + 45	,89322	—	37,16	134,08	3,08	74,58	,7467
46	,89420	—	37,98	134,85	3,13	74,15	,7424
47	,89518	—	38,81	135,63	3,18	73,73	,7382
48	,89613	—	39,64	136,41	3,23	73,31	,7340
49	,89706	—	40,46	137,19	3,27	72,89	,7297

I. Spirit and Water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89797	100	41,29	137,97	3,32	72,48	,7256
51	,89888	—	42,11	138,75	3,36	72,07	,7215
52	,89976	—	42,94	139,53	3,41	71,67	,7176
53	,90063	—	43,76	140,31	3,45	71,27	,7136
54	,90149	—	44,59	141,09	3,50	70,88	,7096
100 + 55	,90234	—	45,42	141,88	3,54	70,48	,7056
56	,90317	—	46,24	142,66	3,58	70,10	,7018
57	,90398	—	47,06	143,44	3,62	69,71	,6979
58	,90479	—	47,89	144,23	3,66	69,33	,6941
59	,90558	—	48,71	145,01	3,70	68,96	,6904
100 + 60	,90638	—	49,54	145,80	3,74	68,59	,6866
61	,90714	—	50,37	146,58	3,79	68,22	,6830
62	,90791	—	51,20	147,37	3,83	67,85	,6794
63	,90866	—	52,02	148,15	3,87	67,50	,6758
64	,90940	—	52,85	148,94	3,91	67,14	,6721
100 + 65	,91013	—	53,67	149,73	3,94	66,79	,6686
66	,91087	—	54,50	150,52	3,98	66,44	,6652
67	,91160	—	55,32	151,30	4,02	66,09	,6617
68	,91232	—	56,15	152,09	4,06	65,75	,6583
69	,91303	—	56,98	152,88	4,10	65,41	,6549
100 + 70	,91373	—	57,80	153,67	4,13	65,08	,6515
71	,91442	—	58,63	154,45	4,18	64,75	,6482
72	,91510	—	59,46	155,24	4,22	64,42	,6449
73	,91577	—	60,28	156,03	4,25	64,09	,6416
74	,91643	—	61,11	156,82	4,29	63,77	,6384
100 + 75	,91708	—	61,93	157,61	4,32	63,45	,6352
76	,91772	—	62,76	158,40	4,36	63,13	,6320
77	,91834	—	63,58	159,19	4,39	62,82	,6289
78	,91897	—	64,41	159,99	4,42	62,51	,6258
79	,91958	—	65,23	160,77	4,46	62,20	,6227
100 + 80	,92017	—	66,06	161,56	4,50	61,90	,6196
81	,92078	—	66,88	162,36	4,52	61,59	,6167
82	,92137	—	67,71	163,15	4,56	61,29	,6136
83	,92195	—	68,53	163,94	4,59	60,99	,6107
84	,92252	—	69,36	164,74	4,62	60,71	,6078
100 + 85	,92309	—	70,19	165,53	4,66	60,41	,6048
86	,92366	—	71,02	166,32	4,70	60,12	,6019
87	,92421	—	71,84	167,12	4,72	59,84	,5990
88	,92475	—	72,67	167,91	4,76	59,56	,5962
89	,92529	—	73,49	168,71	4,78	59,27	,5935
100 + 90	,92583	—	74,32	169,50	4,82	58,99	,5906
91	,92635	—	75,14	170,29	4,85	58,72	,5878
92	,92687	—	75,97	171,09	4,88	58,45	,5851
93	,92739	—	76,79	171,88	4,91	58,18	,5825
94	,92789	—	77,62	172,68	4,94	57,91	,5798
100 + 95	,92840	—	78,45	173,47	4,98	57,64	,5771
96	,92889	—	79,27	174,27	5,00	57,38	,5745
97	,92938	—	80,09	175,07	5,02	57,12	,5719
98	,92987	—	80,92	175,86	5,06	56,86	,5693
99	,93036	—	81,75	176,66	5,09	56,61	,5667

TABLE II. HEAT 58°.

I. Water and Spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93084	100	82,58	177,45	5,13	56,35	,5641
99	,93133	—	83,42	178,26	5,16	56,09	,5616
98	,93183	—	84,27	179,09	5,18	55,84	,5590
97	,93231	—	85,12	179,94	5,18	55,57	,5564
96	,93280	—	86,02	180,79	5,23	55,31	,5538
100 + 95	,93329	—	86,92	181,66	5,26	55,05	,5512
94	,93378	—	87,84	182,56	5,28	54,78	,5484
93	,93427	—	88,79	183,47	5,32	54,50	,5457
92	,93476	—	89,75	184,40	5,35	54,22	,5429
91	,93525	—	90,74	185,36	5,38	53,95	,5401
100 + 90	,93575	—	91,75	186,34	5,41	53,66	,5373
89	,93625	—	92,78	187,34	5,44	53,38	,5344
88	,93676	—	93,84	188,36	5,48	53,09	,5315
87	,93726	—	94,92	189,41	5,51	52,79	,5286
86	,93777	—	96,02	190,48	5,54	52,49	,5256
100 + 85	,93829	—	97,15	191,59	5,56	52,19	,5226
84	,93881	—	98,30	192,71	5,59	51,89	,5196
83	,93934	—	99,49	193,86	5,63	51,59	,5165
82	,93987	—	100,71	195,05	5,66	51,28	,5133
81	,94042	—	101,95	196,26	5,69	50,95	,5101
100 + 80	,94096	—	103,22	197,50	5,72	50,63	,5069
79	,94151	—	104,53	198,77	5,76	50,31	,5036
78	,94205	—	105,87	200,07	5,80	49,98	,5004
77	,94261	—	107,24	201,42	5,82	49,64	,4971
76	,94316	—	108,65	202,79	5,86	49,31	,4937
100 + 75	,94372	—	110,10	204,22	5,88	48,97	,4902
74	,94428	—	111,59	205,67	5,92	48,62	,4868
73	,94484	—	113,11	207,17	5,94	48,27	,4833
72	,94541	—	114,69	208,71	5,98	47,91	,4797
71	,94597	—	116,30	210,30	6,00	47,56	,4761
100 + 70	,94653	—	117,97	211,92	6,05	47,19	,4724
69	,94712	—	119,68	213,59	6,09	46,81	,4687
68	,94771	—	121,44	215,31	6,13	46,44	,4650
67	,94828	—	123,25	217,10	6,15	46,07	,4612
66	,94889	—	125,12	218,93	6,19	45,67	,4573
100 + 65	,94948	—	127,04	220,82	6,22	45,28	,4534
64	,95008	—	129,02	222,77	6,25	44,89	,4494
63	,95069	—	131,07	224,78	6,29	44,48	,4454
62	,95129	—	133,18	226,86	6,32	44,08	,4413
61	,95190	—	135,38	229,02	6,36	43,66	,4371
100 + 60	,95252	—	137,63	231,24	6,39	43,25	,4330
59	,95313	—	139,96	233,54	6,42	42,82	,4287
58	,95376	—	142,37	235,91	6,46	42,39	,4244
57	,95437	—	144,87	238,38	6,49	41,95	,4200
56	,95499	—	147,46	240,92	6,54	41,50	,4155
100 + 55	,95561	—	150,14	243,57	6,57	41,05	,4110
54	,95622	—	152,91	246,32	6,59	40,59	,4064
53	,95684	—	155,79	249,19	6,60	40,13	,4018
52	,95745	—	158,79	252,15	6,64	39,65	,3970
51	,95807	—	161,92	255,25	6,67	39,17	,3922

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Dimi. nution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95868	100	165,16	258,46	6,70	38,69	,3873
49	,95931	—	168,53	261,82	6,71	38,19	,3824
48	,95994	—	172,03	265,28	6,75	37,69	,3774
47	,96057	—	175,69	268,92	6,77	37,18	,3723
46	,96120	—	179,52	272,73	6,79	36,66	,3671
100 + 45	,96182	—	183,52	276,71	6,81	36,14	,3618
44	,96244	—	187,68	280,85	6,83	35,61	,3565
43	,96306	—	192,04	285,20	6,84	35,06	,3510
42	,96368	—	196,61	289,76	6,85	34,51	,3455
41	,96431	—	201,41	294,54	6,87	33,95	,3399
100 + 40	,96493	—	206,45	299,59	6,86	33,38	,3342
39	,96554	—	211,74	304,89	6,85	32,80	,3284
38	,96616	—	217,31	310,46	6,85	32,21	,3225
37	,96678	—	223,19	316,35	6,84	31,61	,3165
36	,96740	—	229,39	322,56	6,83	31,00	,3104
100 + 35	,96802	—	235,94	329,10	6,84	30,39	,3042
34	,96865	—	242,89	336,04	6,85	29,76	,2979
33	,96927	—	250,24	343,43	6,81	29,12	,2915
32	,96990	—	258,06	351,27	6,79	28,47	,2850
31	,97054	—	266,39	359,62	6,77	27,81	,2784
100 + 30	,97116	—	275,26	368,54	6,72	27,13	,2716
29	,97181	—	284,76	378,05	6,71	26,45	,2648
28	,97246	—	294,93	388,26	6,67	25,76	,2578
27	,97312	—	305,86	399,23	6,63	25,05	,2508
26	,97378	—	317,62	411,04	6,58	24,33	,2436
100 + 25	,97446	—	330,32	423,80	6,52	23,60	,2362
24	,97514	—	344,09	437,62	6,47	22,85	,2287
23	,97584	—	359,04	452,65	6,39	22,09	,2212
22	,97655	—	375,36	469,02	6,34	21,32	,2134
21	,97728	—	393,24	486,97	6,27	20,53	,2056
100 + 20	,97801	—	412,90	506,71	6,19	19,73	,1976
19	,97877	—	434,63	528,53	6,10	18,92	,1894
18	,97955	—	458,78	552,75	6,03	18,09	,1811
17	,98034	—	485,77	579,84	5,93	17,25	,1726
16	,98117	—	516,12	610,29	5,83	16,39	,1640
100 + 15	,98202	—	550,54	644,81	5,73	15,51	,1553
14	,98288	—	589,87	684,26	5,61	14,62	,1463
13	,98379	—	635,22	729,76	5,46	13,70	,1372
12	,98474	—	688,18	782,83	5,35	12,77	,1279
11	,98572	—	750,74	845,52	5,22	11,83	,1184
100 + 10	,98674	—	825,81	920,73	5,08	10,86	,1087
9	,98780	—	917,57	1012,66	4,91	9,87	,0989
8	,98891	—	1032,27	1127,52	4,75	8,87	,0888
7	,99008	—	1179,73	1275,16	4,57	7,84	,0785
6	,99132	—	1376,36	1471,94	4,42	6,79	,0680
100 + 5	,99260	—	1651,63	1747,41	4,22	5,72	,0573
4	,99396	—	2064,51	2160,49	4,02	4,63	,0463
3	,99540	—	2752,68	2848,83	3,85	3,51	,0351
2	,99691	—	4129,03	4225,35	3,68	2,37	,0237
1	,99850	—	8258,07	8354,57	3,50	1,20	,0120

TABLE I. HEAT 59°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82547	100	—	100,00	—	100,00	1,0006
1	,82778	—	0,83	100,72	0,11	99,29	,9935
2	,83004	—	1,65	101,44	0,21	98,58	,9865
3	,83124	—	2,48	102,16	0,32	97,88	,9795
4	,83438	—	3,30	102,89	0,41	97,19	,9725
100 + 5	,83646	—	4,12	103,62	0,50	96,50	,9656
6	,83849	—	4,95	104,35	0,60	95,82	,9589
7	,84048	—	5,78	105,10	0,68	95,16	,9522
8	,84242	—	6,61	105,83	0,78	94,49	,9456
9	,84430	—	7,43	106,57	0,86	93,83	,9390
100 + 10	,84615	—	8,26	107,31	0,95	93,19	,9324
11	,84795	—	9,08	108,06	1,02	92,55	,9260
12	,84970	—	9,90	108,80	1,10	91,91	,9196
13	,85143	—	10,73	109,55	1,18	91,27	,9133
14	,85312	—	11,55	110,31	1,24	90,66	,9071
100 + 15	,85477	—	12,38	111,06	1,32	90,04	,9009
16	,85639	—	13,21	111,81	1,40	89,44	,8949
17	,85797	—	14,03	112,57	1,46	88,84	,8889
18	,85953	—	14,86	113,32	1,54	88,24	,8830
19	,86105	—	15,68	114,08	1,60	87,65	,8771
100 + 20	,86256	—	16,51	114,85	1,66	87,07	,8713
21	,86402	—	17,33	115,61	1,72	86,50	,8656
22	,86547	—	18,16	116,36	1,80	85,94	,8599
23	,86688	—	18,98	117,12	1,86	85,38	,8543
24	,86827	—	19,81	117,88	1,93	84,83	,8488
100 + 25	,86964	—	20,63	118,65	1,98	84,28	,8433
26	,87098	—	21,46	119,41	2,05	83,74	,8379
27	,87229	—	22,28	120,18	2,10	83,21	,8326
28	,87360	—	23,12	120,95	2,17	82,68	,8273
29	,87488	—	23,93	121,72	2,21	82,16	,8221
100 + 30	,87614	—	24,76	122,49	2,27	81,65	,8169
31	,87738	—	25,58	123,25	2,33	81,14	,8118
32	,87859	—	26,41	124,02	2,39	80,64	,8068
33	,87980	—	27,24	124,79	2,45	80,14	,8018
34	,88098	—	28,06	125,56	2,50	79,64	,7969
100 + 35	,88214	—	28,89	126,33	2,56	79,16	,7920
36	,88328	—	29,71	127,10	2,61	78,68	,7872
37	,88440	—	30,54	127,87	2,67	78,20	,7825
38	,88550	—	31,37	128,65	2,72	77,73	,7778
39	,88658	—	32,19	129,42	2,77	77,27	,7731
100 + 40	,88765	—	33,02	130,20	2,82	76,81	,7685
41	,88870	—	33,84	130,97	2,87	76,35	,7640
42	,88975	—	34,67	131,75	2,92	75,90	,7595
43	,89078	—	35,49	132,52	2,97	75,46	,7551
44	,89179	—	36,32	133,30	3,02	75,02	,7507
100 + 45	,89277	—	37,14	134,07	3,07	74,59	,7463
46	,89375	—	37,96	134,85	3,11	74,16	,7420
47	,89473	—	38,79	135,62	3,17	73,73	,7378
48	,89568	—	39,62	136,40	3,22	73,31	,7336
49	,89661	—	40,44	137,18	3,26	72,90	,7294

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89752	100	41,27	137,96	3,31	72,49	,7253
51	,89843	—	42,09	138,74	3,35	72,08	,7212
52	,89931	—	42,92	139,52	3,40	71,67	,7172
53	,90018	—	43,74	140,30	3,44	71,27	,7132
54	,90104	—	44,57	141,08	3,49	70,88	,7093
100 + 55	,90189	—	45,40	141,87	3,53	70,49	,7053
56	,90272	—	46,22	142,65	3,57	70,10	,7014
57	,90354	—	47,04	143,43	3,61	69,71	,6976
58	,90435	—	47,87	144,22	3,65	69,33	,6938
59	,90514	—	48,69	145,00	3,69	68,96	,6901
100 + 60	,90595	—	49,52	145,79	3,73	68,60	,6863
61	,90670	—	50,34	146,57	3,77	68,23	,6827
62	,90747	—	51,17	147,36	3,81	67,86	,6791
63	,90822	—	51,99	148,14	3,85	67,50	,6755
64	,90897	—	52,82	148,93	3,89	67,14	,6718
100 + 65	,90970	—	53,64	149,72	3,92	66,79	,6683
66	,91044	—	54,47	150,51	3,96	66,44	,6649
67	,91117	—	55,29	151,29	4,00	66,09	,6614
68	,91189	—	56,12	152,08	4,04	65,75	,6580
69	,91260	—	56,95	152,86	4,09	65,41	,6546
100 + 70	,91330	—	57,77	153,65	4,12	65,08	,6512
71	,91399	—	58,60	154,44	4,16	64,75	,6479
72	,91467	—	59,43	155,22	4,21	64,42	,6446
73	,91534	—	60,25	156,02	4,23	64,09	,6413
74	,91600	—	61,08	156,80	4,28	63,77	,6381
100 + 75	,91665	—	61,90	157,59	4,31	63,45	,6349
76	,91729	—	62,73	158,38	4,35	63,14	,6317
77	,91791	—	63,55	159,18	4,37	62,82	,6286
78	,91854	—	64,38	159,97	4,41	62,51	,6255
79	,91915	—	65,20	160,75	4,45	62,20	,6224
100 + 80	,91975	—	66,03	161,54	4,49	61,90	,6194
81	,92036	—	66,85	162,34	4,51	61,60	,6164
82	,92095	—	67,68	163,13	4,55	61,30	,6134
83	,92152	—	68,50	163,92	4,58	61,00	,6104
84	,92210	—	69,33	164,72	4,61	60,71	,6075
100 + 85	,92267	—	70,15	165,51	4,64	60,42	,6045
86	,92324	—	70,98	166,30	4,68	60,13	,6017
87	,92379	—	71,81	167,10	4,71	59,84	,5988
88	,92433	—	72,63	167,89	4,74	59,56	,5960
89	,92487	—	73,45	168,69	4,76	59,28	,5932
100 + 90	,92541	—	74,28	169,48	4,80	59,00	,5904
91	,92594	—	75,10	170,27	4,83	58,72	,5876
92	,92646	—	75,93	171,07	4,86	58,45	,5849
93	,92698	—	76,75	171,86	4,89	58,18	,5822
94	,92748	—	77,58	172,66	4,92	57,91	,5795
100 + 95	,92799	—	78,41	173,45	4,96	57,65	,5768
96	,92848	—	79,23	174,25	4,98	57,39	,5742
97	,92897	—	80,05	175,05	5,00	57,13	,5716
98	,92946	—	80,88	175,84	5,04	56,87	,5691
99	,92995	—	81,71	176,64	5,07	56,61	,5665

TABLE II. HEAT 59°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93043	100	82,54	177,43	5,11	56,35	,5639
99	,93092	—	83,38	178,24	5,14	56,10	,5613
98	,93142	—	84,23	179,07	5,16	55,84	,5587
97	,93190	—	85,07	179,91	5,16	55,58	,5562
96	,93239	—	85,98	180,77	5,21	55,32	,5535
100 + 95	,93288	—	86,88	181,64	5,24	55,05	,5509
94	,93337	—	87,80	182,53	5,27	54,78	,5481
93	,93386	—	88,75	183,44	5,31	54,51	,5454
92	,93435	—	89,71	184,37	5,34	54,23	,5427
91	,93484	—	90,70	185,34	5,36	53,95	,5398
100 + 90	,93534	—	91,71	186,32	5,39	53,67	,5370
89	,93585	—	92,74	187,31	5,43	53,39	,5342
88	,93636	—	93,79	188,34	5,45	53,10	,5313
87	,93686	—	94,87	189,38	5,49	52,80	,5284
86	,93737	—	95,97	190,45	5,52	52,50	,5254
100 + 85	,93789	—	97,10	191,56	5,54	52,20	,5223
84	,93842	—	98,25	192,68	5,57	51,90	,5193
83	,93895	—	99,44	193,83	5,61	51,60	,5163
82	,93948	—	100,66	195,02	5,64	51,29	,5131
81	,94003	—	101,90	196,23	5,67	50,96	,5099
100 + 80	,94057	—	103,17	197,47	5,70	50,64	,5067
79	,94112	—	104,48	198,74	5,74	50,32	,5034
78	,94167	—	105,82	200,04	5,78	49,99	,5002
77	,94223	—	107,19	201,39	5,80	49,65	,4969
76	,94278	—	108,60	202,76	5,84	49,32	,4935
100 + 75	,94334	—	110,05	204,19	5,86	48,98	,4900
74	,94390	—	111,53	205,64	5,89	48,63	,4866
73	,94446	—	113,05	207,13	5,92	48,28	,4831
72	,94503	—	114,64	208,68	5,96	47,92	,4795
71	,94560	—	116,25	210,26	5,99	47,56	,4760
100 + 70	,94616	—	117,91	211,88	6,03	47,19	,4722
69	,94674	—	119,62	213,55	6,07	46,82	,4685
68	,94734	—	121,38	215,27	6,11	46,45	,4648
67	,94791	—	123,19	217,06	6,13	46,08	,4610
66	,94853	—	125,06	218,89	6,17	45,68	,4571
100 + 65	,94912	—	126,98	220,78	6,20	45,30	,4532
64	,94971	—	128,96	222,73	6,23	44,90	,4492
63	,95033	—	131,01	224,74	6,27	44,49	,4452
62	,95094	—	133,12	226,82	6,30	44,09	,4412
61	,95155	—	135,31	228,97	6,34	43,67	,4370
100 + 60	,95216	—	137,56	231,19	6,37	43,26	,4328
59	,95278	—	139,89	233,49	6,40	42,83	,4285
58	,95341	—	142,30	235,86	6,44	42,40	,4243
57	,95403	—	144,80	238,33	6,47	41,96	,4199
56	,95465	—	147,39	240,87	6,52	41,51	,4154
100 + 55	,95527	—	150,07	243,52	6,55	41,06	,4109
54	,95589	—	152,84	246,27	6,57	40,60	,4063
53	,95651	—	155,72	249,13	6,59	40,14	,4017
52	,95712	—	158,72	252,10	6,62	39,66	,3969
51	,95774	—	161,84	255,19	6,65	39,18	,3921

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95836	100	165,08	258,40	6,68	38,70	,3872
49	,95899	—	168,45	261,75	6,70	38,20	,3823
48	,95963	—	171,95	265,22	6,73	37,70	,3773
47	,96026	—	175,61	268,86	6,75	37,19	,3722
46	,96089	—	179,43	272,66	6,77	36,67	,3670
100 + 45	,96152	—	183,43	276,64	6,79	36,15	,3617
44	,96215	—	187,59	280,77	6,82	35,62	,3564
43	,96277	—	191,95	285,12	6,83	35,07	,3509
42	,96340	—	196,52	289,68	6,84	34,52	,3454
41	,96403	—	201,31	294,46	6,85	33,96	,3398
100 + 40	,96465	—	206,35	299,51	6,84	33,39	,3341
39	,96527	—	211,64	304,80	6,84	32,81	,3283
38	,96590	—	217,20	310,37	6,83	32,22	,3224
37	,96652	—	223,08	316,25	6,83	31,62	,3164
36	,96715	—	229,28	322,46	6,82	31,01	,3103
100 + 35	,96777	—	235,82	329,00	6,82	30,40	,3041
34	,96841	—	242,77	335,94	6,83	29,77	,2978
33	,96904	—	250,12	343,32	6,80	29,13	,2914
32	,96967	—	257,93	351,15	6,78	28,48	,2850
31	,97032	—	266,26	359,50	6,76	27,82	,2784
100 + 30	,97095	—	275,13	368,41	6,72	27,14	,2716
29	,97160	—	284,62	377,92	6,70	26,46	,2648
28	,97226	—	294,79	388,12	6,67	25,77	,2578
27	,97293	—	305,71	399,09	6,62	25,06	,2507
26	,97359	—	317,47	410,89	6,58	24,34	,2435
100 + 25	,97428	—	330,16	423,64	6,52	23,61	,2362
24	,97497	—	343,92	437,45	6,47	22,86	,2287
23	,97567	—	358,87	452,48	6,39	22,10	,2211
22	,97639	—	375,18	468,83	6,35	21,33	,2134
21	,97712	—	393,05	486,77	6,28	20,54	,2055
100 + 20	,97786	—	412,70	506,50	6,20	19,74	,1975
19	,97863	—	434,42	528,31	6,11	18,93	,1894
18	,97941	—	458,55	552,52	6,03	18,10	,1811
17	,98020	—	485,53	579,59	5,94	17,26	,1726
16	,98104	—	515,87	610,02	5,85	16,40	,1640
100 + 15	,98189	—	550,27	644,53	5,74	15,52	,1552
14	,98276	—	589,58	683,96	5,62	14,62	,1463
13	,98368	—	634,91	729,43	5,48	13,71	,1372
12	,98463	—	687,84	782,47	5,37	12,78	,1279
11	,98562	—	750,37	845,13	5,24	11,84	,1184
100 + 10	,98664	—	825,40	920,30	5,10	10,86	,1087
9	,98771	—	917,12	1012,18	4,94	9,88	,0988
8	,98882	—	1031,76	1126,98	4,78	8,87	,0888
7	,99000	—	1179,15	1274,54	4,61	7,84	,0785
6	,99124	—	1375,68	1471,23	4,45	6,80	,0680
100 + 5	,99252	—	1650,81	1746,55	4,26	5,72	,0573
4	,99388	—	2063,50	2159,43	4,07	4,63	,0463
3	,99532	—	2751,34	2847,43	3,91	3,51	,0351
2	,99683	—	4127,00	4223,27	3,73	2,37	,0237
1	,99842	—	8254,02	8350,45	3,57	1,20	,0120

TABLE I. HEAT 60°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82500	100	—	100,00	—	100,00	1,0000
1	,82731	—	0,83	100,72	0,11	99,29	,9929
2	,82957	—	1,65	101,44	0,21	98,58	,9858
3	,83177	—	2,47	102,16	0,31	97,88	,9789
4	,83391	—	3,30	102,89	0,41	97,19	,9719
100 + 5	,83599	—	4,12	103,62	0,50	96,51	,9651
6	,83802	—	4,95	104,35	0,60	95,83	,9583
7	,84001	—	5,77	105,09	0,68	95,16	,9516
8	,84195	—	6,60	105,83	0,77	94,50	,9450
9	,84384	—	7,42	106,57	0,85	93,84	,9384
100 + 10	,84568	—	8,25	107,31	0,94	93,19	,9319
11	,84748	—	9,07	108,05	1,02	92,55	,9255
12	,84924	—	9,90	108,80	1,10	91,91	,9191
13	,85096	—	10,72	109,55	1,17	91,28	,9128
14	,85265	—	11,55	110,30	1,25	90,66	,9066
100 + 15	,85430	—	12,37	111,05	1,32	90,04	,9005
16	,85592	—	13,20	111,81	1,39	89,44	,8944
17	,85750	—	14,02	112,56	1,46	88,84	,8884
18	,85906	—	14,85	113,32	1,53	88,25	,8825
19	,86058	—	15,67	114,08	1,59	87,66	,8766
100 + 20	,86208	—	16,50	114,84	1,66	87,08	,8708
21	,86355	—	17,32	115,60	1,72	86,51	,8651
22	,86500	—	18,15	116,36	1,79	85,94	,8594
23	,86642	—	18,97	117,12	1,85	85,38	,8538
24	,86781	—	19,80	117,88	1,92	84,83	,8483
100 + 25	,86918	—	20,62	118,64	1,98	84,28	,8428
26	,87052	—	21,45	119,41	2,04	83,74	,8374
27	,87183	—	22,27	120,18	2,09	83,21	,8321
28	,87314	—	23,10	120,94	2,16	82,68	,8268
29	,87442	—	23,92	121,71	2,21	82,16	,8216
100 + 30	,87569	—	24,75	122,48	2,27	81,65	,8165
31	,87692	—	25,57	123,24	2,33	81,14	,8114
32	,87814	—	26,40	124,01	2,39	80,64	,8064
33	,87935	—	27,22	124,78	2,44	80,14	,8014
34	,88053	—	28,05	125,55	2,50	79,65	,7965
100 + 35	,88169	—	28,87	126,32	2,55	79,16	,7916
36	,88283	—	29,70	127,09	2,61	78,68	,7868
37	,88395	—	30,52	127,86	2,66	78,21	,7821
38	,88505	—	31,35	128,64	2,71	77,74	,7774
39	,88613	—	32,17	129,41	2,76	77,27	,7727
100 + 40	,88720	—	33,00	130,19	2,81	76,81	,7681
41	,88825	—	33,82	130,96	2,86	76,36	,7636
42	,88929	—	34,65	131,74	2,91	75,91	,7591
43	,89032	—	35,47	132,51	2,96	75,47	,7547
44	,89133	—	36,30	133,29	3,01	75,03	,7503
100 + 45	,89232	—	37,12	134,06	3,06	74,59	,7459
46	,89330	—	37,95	134,84	3,11	74,16	,7416
47	,89427	—	38,77	135,61	3,16	73,74	,7374
48	,89522	—	39,60	136,39	3,21	73,32	,7332
49	,89615	—	40,42	137,17	3,25	72,90	,7290

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89707	100	41,25	137,95	3,30	72,49	,7249
51	,89797	—	42,07	138,73	3,34	72,08	,7208
52	,89886	—	42,90	139,51	3,39	71,68	,7168
53	,89973	—	43,72	140,29	3,43	71,28	,7128
54	,90059	—	44,55	141,07	3,48	70,89	,7089
100 + 55	,90144	—	45,38	141,86	3,52	70,49	,7049
56	,90227	—	46,20	142,64	3,56	70,11	,7011
57	,90309	—	47,02	143,42	3,60	69,72	,6972
58	,90391	—	47,85	144,21	3,64	69,34	,6934
59	,90470	—	48,67	144,99	3,68	68,97	,6897
100 + 60	,90549	—	49,50	145,78	3,72	68,60	,6860
61	,90626	—	50,32	146,56	3,76	68,23	,6823
62	,90703	—	51,15	147,35	3,80	67,87	,6787
63	,90778	—	51,97	148,13	3,84	67,51	,6751
64	,90853	—	52,80	148,92	3,88	67,15	,6715
100 + 65	,90927	—	53,62	149,71	3,91	66,80	,6680
66	,91001	—	54,45	150,50	3,95	66,45	,6645
67	,91074	—	55,27	151,28	3,99	66,10	,6610
68	,91146	—	56,10	152,07	4,03	65,76	,6576
69	,91217	—	56,92	152,85	4,07	65,42	,6542
100 + 70	,91287	—	57,75	153,64	4,11	65,09	,6509
71	,91356	—	58,57	154,42	4,15	64,76	,6476
72	,91424	—	59,40	155,21	4,19	64,43	,6443
73	,91491	—	60,22	156,00	4,22	64,10	,6410
74	,91557	—	61,05	156,79	4,26	63,78	,6378
100 + 75	,91622	—	61,87	157,58	4,29	63,46	,6346
76	,91686	—	62,70	158,37	4,33	63,14	,6314
77	,91748	—	63,52	159,16	4,36	62,83	,6283
78	,91811	—	64,35	159,95	4,40	62,52	,6252
79	,91872	—	65,17	160,74	4,43	62,21	,6221
100 + 80	,91933	—	66,00	161,53	4,47	61,91	,6191
81	,91993	—	66,82	162,32	4,50	61,61	,6161
82	,92052	—	67,65	163,11	4,54	61,31	,6131
83	,92110	—	68,47	163,90	4,57	61,01	,6101
84	,92168	—	69,30	164,70	4,60	60,72	,6072
100 + 85	,92225	—	70,12	165,49	4,63	60,43	,6043
86	,92281	—	70,95	166,29	4,66	60,14	,6014
87	,92336	—	71,77	167,08	4,69	59,85	,5985
88	,92391	—	72,60	167,87	4,73	59,57	,5957
89	,92445	—	73,42	168,66	4,76	59,29	,5929
100 + 90	,92499	—	74,25	169,46	4,79	59,01	,5901
91	,92552	—	75,07	170,25	4,82	58,73	,5873
92	,92604	—	75,90	171,05	4,85	58,46	,5846
93	,92656	—	76,72	171,84	4,88	58,19	,5819
94	,92707	—	77,55	172,64	4,91	57,92	,5792
100 + 95	,92758	—	78,37	173,43	4,94	57,66	,5766
96	,92807	—	79,20	174,23	4,97	57,40	,5740
97	,92856	—	80,02	175,02	5,00	57,14	,5714
98	,92905	—	80,85	175,82	5,03	56,88	,5688
99	,92954	—	81,68	176,62	5,06	56,62	,5662

TABLE II. HEAT 60°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,93002	100	82,50	177,41	5,09	56,36	,5636
99	,93051	—	83,34	178,22	5,12	56,11	,5611
98	,93100	—	84,19	179,05	5,14	55,85	,5585
97	,93149	—	85,02	179,89	5,13	55,59	,5559
96	,93198	—	85,94	180,74	5,20	55,33	,5533
100 + 95	,93247	—	86,84	181,61	5,23	55,06	,5506
94	,93296	—	87,76	182,50	5,26	54,79	,5479
93	,93345	—	88,71	183,42	5,29	54,52	,5452
92	,93394	—	89,67	184,35	5,32	54,24	,5424
91	,93443	—	90,66	185,31	5,35	53,96	,5396
100 + 90	,93493	—	91,67	186,29	5,38	53,68	,5368
89	,93544	—	92,70	187,29	5,41	53,39	,5339
88	,93595	—	93,75	188,31	5,44	53,10	,5310
87	,93646	—	94,83	189,35	5,48	52,81	,5281
86	,93697	—	95,93	190,42	5,51	52,51	,5251
100 + 85	,93749	—	97,06	191,53	5,53	52,21	,5221
84	,93802	—	98,21	192,65	5,56	51,91	,5191
83	,93855	—	99,39	193,80	5,59	51,60	,5160
82	,93909	—	100,61	194,99	5,62	51,29	,5129
81	,93963	—	101,85	196.20	5,65	50,97	,5097
100 + 80	,94018	—	103,12	197,44	5,68	50,65	,5065
79	,94073	—	104,43	198,71	5,72	50,32	,5032
78	,94128	—	105,77	200,01	5,76	50,00	,5000
77	,94184	—	107,14	201,35	5,79	49,66	,4966
76	,94240	—	108,55	202,73	5,82	49,33	,4933
100 + 75	,94296	—	110,00	204,15	5,85	48,98	,4898
74	,94352	—	111,48	205,60	5,88	48,64	,4864
73	,94408	—	113,01	207,10	5,91	48,29	,4829
72	,94465	—	114,58	208,64	5,94	47,93	,4793
71	,94522	—	116,20	210,22	5,98	47,57	,4757
100 + 70	,94579	—	117,86	211,84	6,02	47,20	,4720
69	,94637	—	119,56	213,51	6,05	46,83	,4683
68	,94696	—	121,32	215,24	6,08	46,46	,4646
67	,94756	—	123,13	217,02	6,11	46,08	,4608
66	,94816	—	125,00	218,85	6,15	45,69	,4569
100 + 65	,94876	—	126,92	220,74	6,18	45,30	,4530
64	,94936	—	128,90	222,69	6,21	44,91	,4491
63	,94997	—	130,95	224,70	6,25	44,50	,4450
62	,95058	—	133,06	226,78	6,28	44,10	,4410
61	,95119	—	135,25	228,93	6,32	43,68	,4368
100 + 60	,95181	—	137,50	231,14	6,36	43,26	,4326
59	,95243	—	139,82	233,44	6,38	42,84	,4284
58	,95305	—	142,23	235,82	6,41	42,41	,4241
57	,95368	—	144,73	238,28	6,45	41,97	,4197
56	,95430	—	147,32	240,82	6,50	41,52	,4152
100 + 55	,95493	—	150,00	243,47	6,53	41,07	,4107
54	,95555	—	152,77	246,22	6,55	40,61	,4061
53	,95617	—	155,65	249,08	6,57	40,15	,4015
52	,95679	—	158,65	252,05	6,60	39,67	,3967
51	,95741	—	161,77	255,14	6,63	39,19	,3919

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95804	100	165,00	258,34	6,66	38,71	,3871
49	,95867	—	168,37	261,68	6,69	38,21	,3821
48	,95931	—	171,87	265,16	6,71	37,71	,3771
47	,95995	—	175,53	268,80	6,73	37,20	,3720
46	,96058	—	179,35	272,59	6,76	36,68	,3668
100 + 45	,96122	—	183,34	276,56	6,78	36,16	,3616
44	,96185	—	187,50	280,70	6,80	35,63	,3563
43	,96248	—	191,86	285,05	6,81	35,08	,3508
42	,96311	—	196,43	289,60	6,83	34,53	,3453
41	,96374	—	201,21	294,38	6,83	33,97	,3397
100 + 40	,96437	—	206,25	299,42	6,83	33,40	,3340
39	,96500	—	211,54	304,71	6,83	32,82	,3282
38	,96563	—	217,10	310,28	6,82	32,23	,3223
37	,96626	—	222,97	316,15	6,82	31,63	,3163
36	,96689	—	229,17	322,36	6,81	31,02	,3102
100 + 35	,96752	—	235,71	328,90	6,81	30,40	,3040
34	,96816	—	242,65	335,84	6,81	29,78	,2978
33	,96880	—	250,00	343,21	6,79	29,14	,2914
32	,96944	—	257,81	351,04	6,77	28,49	,2849
31	,97009	—	266,13	359,38	6,75	27,83	,2783
100 + 30	,97074	—	275,00	368,28	6,72	27,15	,2715
29	,97139	—	284,48	377,79	6,69	26,47	,2647
28	,97206	—	294,64	387,99	6,65	25,77	,2577
27	,97273	—	305,56	398,95	6,61	25,07	,2507
26	,97340	—	317,31	410,74	6,57	24,35	,2435
100 + 25	,97410	—	330,00	423,48	6,52	23,61	,2361
24	,97479	—	343,75	437,29	6,46	22,87	,2287
23	,97550	—	358,70	452,31	6,39	22,11	,2211
22	,97622	—	375,00	468,64	6,36	21,34	,2134
21	,97696	—	392,86	486,58	6,28	20,55	,2055
100 + 20	,97771	—	412,50	506,29	6,21	19,75	,1975
19	,97848	—	434,21	528,08	6,13	18,94	,1894
18	,97926	—	458,33	552,29	6,04	18,11	,1811
17	,98006	—	485,29	579,34	5,95	17,26	,1726
16	,98090	—	515,62	609,76	5,86	16,40	,1640
100 + 15	,98176	—	550,00	644,25	5,75	15,52	,1552
14	,98264	—	589,29	683,66	5,63	14,63	,1463
13	,98356	—	634,61	729,10	5,51	13,72	,1372
12	,98452	—	687,50	782,11	5,39	12,79	,1279
11	,98551	—	750,00	844,74	5,26	11,84	,1184
100 + 10	,98654	—	825,00	919,87	5,13	10,87	,1087
9	,98761	—	916,67	1011,70	4,97	9,88	,0988
8	,98873	—	1031,25	1126,44	4,81	8,88	,0888
7	,98991	—	1178,57	1273,92	4,65	7,85	,0785
6	,99115	—	1375,00	1470,52	4,48	6,80	,0680
100 + 5	,99244	—	1650,00	1745,70	4,30	5,73	,0573
4	,99380	—	2062,50	2158,37	4,13	4,63	,0463
3	,99524	—	2750,00	2846,04	3,96	3,51	,0351
2	,99675	—	4125,00	4221,21	3,79	2,37	,0237
1	,99834	—	8250,00	8346,38	3,62	1,20	,0120

TABLE I.

HEAT 61°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82453	100	—	100,00	—	100,00	,9994
1	,82684	—	0,82	100,72	0,10	99,29	,9924
2	,82910	—	1,65	101,44	0,21	98,58	,9853
3	,83130	—	2,47	102,16	0,31	97,88	,9784
4	,83344	—	3,30	102,89	0,41	97,19	,9714
100 + 5	,83552	—	4,12	103,62	0,50	96,51	,9645
6	,83755	—	4,95	104,35	0,60	95,83	,9578
7	,83954	—	5,77	105,09	0,68	95,16	,9511
8	,84148	—	6,60	105,83	0,77	94,50	,9445
9	,84337	—	7,42	106,57	0,85	93,84	,9379
100 + 10	,84520	—	8,25	107,31	0,94	93,19	,9314
11	,84701	—	9,07	108,05	1,02	92,55	,9250
12	,84877	—	9,90	108,80	1,10	91,91	,9186
13	,85049	—	10,72	109,55	1,17	91,28	,9123
14	,85218	—	11,54	110,30	1,24	90,66	,9061
100 + 15	,85382	—	12,36	111,05	1,31	90,04	,9000
16	,85545	—	13,19	111,81	1,38	89,44	,8939
17	,85703	—	14,02	112,56	1,46	88,84	,8879
18	,85860	—	14,84	113,32	1,52	88,25	,8820
19	,86012	—	15,66	114,08	1,58	87,66	,8762
100 + 20	,86162	—	16,49	114,84	1,65	87,08	,8703
21	,86309	—	17,31	115,60	1,71	86,51	,8646
22	,86454	—	18,14	116,35	1,79	85,94	,8589
23	,86596	—	18,96	117,11	1,85	85,38	,8534
24	,86735	—	19,79	117,87	1,92	84,83	,8479
100 + 25	,86872	—	20,61	118,64	1,97	84,28	,8424
26	,87006	—	21,44	119,40	2,04	83,74	,8370
27	,87137	—	22,26	120,17	2,09	83,21	,8316
28	,87268	—	23,09	120,94	2,15	82,68	,8264
29	,87396	—	23,91	121,71	2,20	82,16	,8212
100 + 30	,87523	—	24,74	122,48	2,26	81,65	,8161
31	,87646	—	25,56	123,23	2,33	81,15	,8110
32	,87768	—	26,39	124,00	2,39	80,64	,8060
33	,87889	—	27,21	124,78	2,43	80,14	,8010
34	,88007	—	28,04	125,55	2,49	79,65	,7961
100 + 35	,88123	—	28,86	126,32	2,54	79,16	,7912
36	,88237	—	29,69	127,09	2,60	78,68	,7864
37	,88349	—	30,51	127,85	2,66	78,21	,7817
38	,88459	—	31,33	128,63	2,70	77,74	,7770
39	,88567	—	32,16	129,40	2,76	77,28	,7723
100 + 40	,88674	—	32,98	130,18	2,80	76,82	,7677
41	,88780	—	33,80	130,95	2,85	76,36	,7632
42	,88884	—	34,63	131,73	2,90	75,91	,7588
43	,88987	—	35,45	132,50	2,95	75,47	,7544
44	,89088	—	36,28	133,28	3,00	75,03	,7500
100 + 45	,89186	—	37,10	134,05	3,05	74,60	,7456
46	,89285	—	37,93	134,83	3,10	74,17	,7413
47	,89382	—	38,75	135,60	3,15	73,74	,7371
48	,89477	—	39,58	136,38	3,20	73,32	,7329
49	,89570	—	40,40	137,16	3,24	72,91	,7286

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89662	100	41,23	137,94	3,29	72,50	,7245
51	,89752	—	42,05	138,72	3,33	72,09	,7205
52	,89841	—	42,88	139,50	3,38	71,69	,7165
53	,89928	—	43,70	140,28	3,42	71,28	,7125
54	,90014	—	44,52	141,06	3,46	70,89	,7086
100 + 55	,90100	—	45,35	141,85	3,50	70,50	,7046
56	,90183	—	46,17	142,62	3,55	70,12	,7007
57	,90265	—	46,99	143,40	3,59	69,73	,6968
58	,90347	—	47,82	144,19	3,63	69,35	,6931
59	,90426	—	48,64	144,97	3,67	68,97	,6893
100 + 60	,90504	—	49,47	145,76	3,71	68,60	,6856
61	,90582	—	50,29	146,54	3,75	68,24	,6820
62	,90659	—	51,12	147,33	3,79	67,88	,6783
63	,90734	—	51,94	148,11	3,83	67,52	,6748
64	,90809	—	52,77	148,90	3,87	67,16	,6712
100 + 65	,90883	—	53,59	149,69	3,90	66,80	,6676
66	,90957	—	54,42	150,48	3,94	66,45	,6642
67	,91030	—	55,24	151,26	3,98	66,11	,6607
68	,91102	—	56,07	152,05	4,02	65,76	,6573
69	,91173	—	56,89	152,83	4,06	65,42	,6539
100 + 70	,91242	—	57,72	153,62	4,10	65,09	,6506
71	,91312	—	58,54	154,41	4,13	64,76	,6473
72	,91380	—	59,37	155,19	4,18	64,43	,6440
73	,91447	—	60,19	155,98	4,21	64,10	,6407
74	,91513	—	61,02	156,77	4,25	63,78	,6375
100 + 75	,91578	—	61,84	157,56	4,28	63,47	,6343
76	,91642	—	62,67	158,35	4,32	63,15	,6311
77	,91704	—	63,49	159,14	4,35	62,84	,6280
78	,91767	—	64,32	159,93	4,39	62,52	,6249
79	,91829	—	65,14	160,72	4,42	62,21	,6218
100 + 80	,91890	—	65,96	161,51	4,45	61,91	,6188
81	,91950	—	66,78	162,30	4,48	61,61	,6158
82	,92009	—	67,61	163,09	4,52	61,31	,6128
83	,92067	—	68,43	163,88	4,55	61,01	,6098
84	,92125	—	69,26	164,68	4,58	60,72	,6069
100 + 85	,92182	—	70,08	165,48	4,60	60,43	,6040
86	,92238	—	70,91	166,27	4,64	60,14	,6011
87	,92293	—	71,73	167,07	4,66	59,86	,5983
88	,92348	—	72,56	167,86	4,70	59,58	,5954
89	,92402	—	73,38	168,64	4,74	59,29	,5926
100 + 90	,92455	—	74,21	169,44	4,77	59,01	,5898
91	,92509	—	75,03	170,24	4,79	58,74	,5871
92	,92562	—	75,86	171,03	4,83	58,47	,5844
93	,92614	—	76,68	171,82	4,86	58,20	,5816
94	,92665	—	77,51	172,62	4,89	57,93	,5789
100 + 95	,92716	—	78,33	173,41	4,92	57,66	,5763
96	,92765	—	79,16	174,20	4,96	57,40	,5738
97	,92814	—	79,98	175,00	4,98	57,14	,5712
98	,92864	—	80,81	175,80	5,01	56,88	,5686
99	,92913	—	81,64	176,59	5,05	56,63	,5660

TABLE II. HEAT 61°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,92961	100	82,46	177,38	5,08	56,37	,5634
99	,93010	—	83,29	178,19	5,10	56,11	,5609
98	,93059	—	84,14	179,02	5,12	55,86	,5583
97	,93108	—	84,98	179,86	5,12	55,60	,5557
96	,93157	—	85,89	180,71	5,18	55,33	,5531
100 + 95	,93206	—	86,79	181,59	5,20	55,07	,5504
94	,93255	—	87,72	182,47	5,25	54,80	,5477
93	,93304	—	88,66	183,40	5,26	54,53	,5450
92	,93353	—	89,62	184,32	5,30	54,25	,5422
91	,93402	—	90,61	185,29	5,32	53,97	,5394
100 + 90	,93452	—	91,62	186,26	5,36	53,69	,5366
89	,93503	—	92,65	187,26	5,39	53,40	,5337
88	,93554	—	93,70	188,28	5,42	53,11	,5308
87	,93605	—	94,78	189,33	5,45	52,81	,5279
86	,93657	—	95,88	190,40	5,48	52,52	,5249
100 + 85	,93709	—	97,01	191,50	5,51	52,22	,5219
84	,93762	—	98,16	192,63	5,53	51,91	,5189
83	,93815	—	99,34	193,78	5,56	51,61	,5158
82	,93870	—	100,56	194,96	5,60	51,30	,5127
81	,93924	—	101,80	196,17	5,63	50,98	,5095
100 + 80	,93979	—	103,07	197,41	5,66	50,66	,5063
79	,94034	—	104,38	198,68	5,70	50,33	,5030
78	,94089	—	105,71	199,97	5,74	50,00	,4998
77	,94145	—	107,09	201,32	5,77	49,67	,4964
76	,94201	—	108,49	202,69	5,80	49,33	,4931
100 + 75	,94257	—	109,94	204,11	5,83	48,99	,4897
74	,94313	—	111,42	205,56	5,86	48,65	,4862
73	,94369	—	112,95	207,06	5,89	48,30	,4827
72	,94427	—	114,52	208,60	5,92	47,94	,4791
71	,94484	—	116,13	210,18	5,95	47,58	,4756
100 + 70	,94540	—	117,80	211,80	6,00	47,21	,4719
69	,94599	—	119,50	213,48	6,02	46,84	,4682
68	,94659	—	121,26	215,20	6,06	46,47	,4645
67	,94719	—	123,07	216,98	6,09	46,09	,4607
66	,94779	—	124,94	218,81	6,13	45,70	,4568
100 + 65	,94839	—	126,86	220,70	6,16	45,31	,4529
64	,94899	—	128,83	222,65	6,18	44,91	,4489
63	,94961	—	130,88	224,66	6,22	44,51	,4449
62	,95022	—	132,99	226,74	6,25	44,10	,4409
61	,95083	—	135,18	228,88	6,30	43,69	,4367
100 + 60	,95145	—	137,43	231,10	6,33	43,27	,4325
59	,95207	—	139,75	233,40	6,35	42,85	,4283
58	,95270	—	142,16	235,77	6,39	42,41	,4240
57	95333	—	144,66	238,23	6,43	41,97	,4196
56	,95395	—	147,25	240,77	6,48	41,53	,4151
100 + 55	,95458	—	149,92	243,42	6,50	41,08	,4106
54	,95521	—	152,69	246,16	6,53	40,62	,4060
53	,95583	—	155,57	249,02	6,55	40,15	,4014
52	,95645	—	158,57	252,00	6,57	39,68	,3966
51	95707	—	161,69	255,08	6,61	39,20	,3918

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95771	100	164,92	258,28	6,64	38,71	,3869
49	,95834	—	168,29	261,62	6,67	38,22	,3820
48	,95898	—	171,78	265,10	6,68	37,72	,3770
47	,95962	—	175,44	268,73	6,71	37,21	,3719
46	,96026	—	179,26	272,52	6,74	36,69	,3667
100 + 45	,96090	—	183,25	276,49	6,76	36,16	,3615
44	,96154	—	187,41	280,63	6,78	35,63	,3562
43	,96217	—	191,76	284,97	6,79	35,08	,3507
42	,96281	—	196,33	289,52	6,81	34,53	,3452
41	,96344	—	201,11	294,30	6,81	33,97	,3396
100 + 40	,96408	—	206,15	299,34	6,81	33,40	,3339
39	,96471	—	211,43	304,62	6,81	32,83	,3281
38	,96535	—	216,99	310,19	6,80	32,24	,3222
37	,96598	—	222,86	316,06	6,80	31,64	,3162
36	,96662	—	229,06	322,25	6,81	31,03	,3101
100 + 35	,96725	—	235,59	328,79	6,80	30,41	,3040
34	,96791	—	242,53	335,73	6,80	29,78	,2977
33	,96855	—	249,88	343,10	6,78	29,14	,2913
32	,96920	—	257,68	350,93	6,75	28,49	,2848
31	,96986	—	266,00	359,26	6,74	27,83	,2782
100 + 30	,97051	—	274,86	368,16	6,70	27,16	,2715
29	,97117	—	284,34	377,65	6,69	26,48	,2647
28	,97185	—	294,50	387,85	6,65	25,78	,2577
27	,97252	—	305,41	398,80	6,61	25,08	,2507
26	,97320	—	317,15	410,58	6,57	24,36	,2435
100 + 25	,97389	—	329,84	423,32	6,52	23,62	,2361
24	,97460	—	343,58	437,12	6,46	22,87	,2287
23	,97532	—	358,52	452,13	6,39	22,12	,2211
22	,97604	—	374,82	468,45	6,37	21,35	,2134
21	,97679	—	392,67	486,38	6,29	20,56	,2055
100 + 20	,97755	—	412,30	506,08	6,22	19,76	,1975
19	,97832	—	434,00	527,86	6,14	18,95	,1894
18	,97911	—	458,11	552,05	6,06	18,11	,1811
17	,97992	—	485,06	579,09	5,97	17,27	,1726
16	,98076	—	515,37	609,50	5,87	16,41	,1640
100 + 15	,98162	—	549,73	643,97	5,76	15,53	,1552
14	,98251	—	589,00	683,36	5,64	14,63	,1463
13	,98343	—	634,30	728,77	5,53	13,72	,1372
12	,98440	—	687,17	781,76	5,41	12,79	,1279
11	,98539	—	749,64	844,36	5,28	11,84	,1184
100 + 10	,98642	—	824,60	919,45	5,15	10,87	,1087
9	,98750	—	916,23	1011,23	5,00	9,89	,0988
8	,98862	—	1030,75	1125,91	4,84	8,88	,0888
7	,98981	—	1178,00	1273,32	4,68	7,85	,0785
6	,99105	—	1374,34	1469,82	4,52	6,80	,0680
100 + 5	,99234	—	1649,21	1744,86	4,25	5,73	,0573
4	,99371	—	2061,51	2157,33	4,18	4,63	,0463
3	,99515	—	2748,67	2844,66	4,01	3,51	,0351
2	,99666	—	4123,01	4219,16	3,85	2,37	,0237
1	,99825	—	8246,02	8342,33	3,69	1,20	,0120

TABLE I. HEAT 62°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82405	100	—	100,00	—	100,00	,9988
1	,82637	—	0,82	100,72	0,10	99,29	,9918
2	,82863	—	1,65	101,44	0,21	98,58	,9848
3	,83083	—	2,47	102,16	0,31	97,88	,9778
4	,83297	—	3,30	102,89	0,41	97,19	,9709
100 + 5	,83504	—	4,12	103,62	0,50	96,51	,9640
6	,83708	—	4,95	104,35	0,60	95,83	,9573
7	,83907	—	5,77	105,09	0,68	95,16	,9506
8	,84101	—	6,59	105,83	0,76	94,50	,9440
9	,84290	—	7,42	106,57	0,85	93,84	,9374
100 + 10	,84473	—	8,24	107,31	0,93	93,19	,9309
11	,84654	—	9,06	108,05	1,01	92,55	,9245
12	,84830	—	9,89	108,80	1,09	91,91	,9181
13	,85002	—	10,71	109,55	1,16	91,28	,9118
14	,85171	—	11,54	110,30	1,24	90,66	,9056
100 + 15	,85335	—	12,36	111,05	1,31	90,04	,8995
16	,85498	—	13,18	111,80	1,38	89,44	,8934
17	,85656	—	14,01	112,56	1,45	88,84	,8874
18	,85813	—	14,83	113,31	1,52	88,25	,8815
19	,85965	—	15,65	114,07	1,58	87,66	,8757
100 + 20	,86115	—	16,48	114,83	1,65	87,08	,8698
21	,86263	—	17,30	115,59	1,71	86,51	,8641
22	,86407	—	18,13	116,35	1,78	85,95	,8585
23	,86549	—	18,95	117,11	1,84	85,39	,8529
24	,86689	—	19,78	117,87	1,91	84,84	,8474
100 + 25	,86825	—	20,60	118,63	1,97	84,29	,8419
26	,86960	—	21,43	119,40	2,03	83,75	,8365
27	,87091	—	22,25	120,17	2,08	83,22	,8312
28	,87222	—	23,08	120,93	2,15	82,69	,8259
29	,87350	—	23,90	121,70	2,20	82,17	,8208
100 + 30	,87476	—	24,73	122,47	2,26	81,65	,8156
31	,87600	—	25,55	123,23	2,32	81,15	,8106
32	,87722	—	26,38	124,00	2,38	80,65	,8055
33	,87843	—	27,19	124,77	2,42	80,15	,8006
34	,87961	—	28,02	125,54	2,48	79,65	,7957
100 + 35	,88076	—	28,85	126,31	2,54	79,17	,7908
36	,88191	—	29,67	127,08	2,59	78,69	,7860
37	,88303	—	30,49	127,85	2,64	78,22	,7813
38	,88413	—	31,32	128,62	2,70	77,75	,7766
39	,88521	—	32,14	129,39	2,75	77,28	,7719
100 + 40	,88628	—	32,97	130,17	2,80	76,82	,7674
41	,88734	—	33,79	130,94	2,85	76,37	,7628
42	,88839	—	34,62	131,72	2,90	75,92	,7584
43	,88942	—	35,44	132,49	2,95	75,48	,7540
44	,89043	—	36,26	133,27	2,99	75,04	,7496
100 + 45	,89141	—	37,09	134,04	3,05	74,60	,7452
46	,89240	—	37,91	134,82	3,09	74,17	,7409
47	,89337	—	38,73	135,59	3,14	73,75	,7367
48	,89432	—	39,56	136,37	3,19	73,33	,7325
49	,89525	—	40,38	137,15	3,23	72,91	,7283

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89617	100	41,21	137,93	3,28	72,50	,7242
51	,89707	—	42,03	138,71	3,32	72,09	,7201
52	,89796	—	42,86	139,49	3,37	71,69	,7161
53	,89883	—	43,68	140,27	3,41	71,29	,7121
54	,89969	—	44,50	141,05	3,45	70,90	,7082
100 + 55	,90055	—	45,33	141,83	3,50	70,51	,7042
56	,90138	—	46,15	142,61	3,54	70,12	,7004
57	,90221	—	46,97	143,39	3,58	69,73	,6965
58	,90302	—	47,80	144,18	3,62	69,35	,6928
59	,90382	—	48,62	144,96	3,66	68,98	,6890
100 + 60	,90460	—	49,45	145,75	3,70	68,61	,6853
61	,90538	—	50,27	146,53	3,74	68,24	,6816
62	,90615	—	51,10	147,32	3,78	67,88	,6780
63	,90690	—	51,92	148,10	3,82	67,52	,6745
64	,90765	—	52,75	148,89	3,86	67,16	,6709
100 + 65	,90839	—	53,56	149,68	3,88	66,81	,6673
66	,90913	—	54,40	150,47	3,93	66,46	,6639
67	,90986	—	55,21	151,25	3,96	66,11	,6604
68	,91058	—	56,05	152,04	4,01	65,77	,6570
69	,91129	—	56,87	152,82	4,05	65,43	,6536
100 + 70	,91198	—	57,69	153,61	4,08	65,16	,6503
71	,91268	—	58,51	154,39	4,12	64,77	,6470
72	,91336	—	59,34	155,18	4,16	64,44	,6437
73	,91403	—	60,16	155,97	4,19	64,11	,6404
74	,91469	—	60,99	156,76	4,23	63,79	,6372
100 + 75	,91533	—	61,81	157,55	4,26	63,47	,6340
76	,91598	—	62,64	158,34	4,30	63,16	,6308
77	,91660	—	63,46	159,13	4,33	62,84	,6277
78	,91723	—	64,29	159,92	4,37	62,53	,6246
79	,91786	—	65,11	160,71	4,40	62,22	,6215
100 + 80	,91847	—	65,93	161,50	4,43	61,92	,6185
81	,91907	—	66,75	162,29	4,46	61,62	,6155
82	,91966	—	67,58	163,07	4,51	61,32	,6125
83	,92024	—	68,40	163,87	4,53	61,02	,6095
84	,92082	—	69,23	164,67	4,56	60,73	,6066
100 + 85	,92139	—	70,05	165,46	4,59	60,44	,6037
86	,92195	—	70,88	166,25	4,63	60,15	,6008
87	,92250	—	71,70	167,05	4,65	59,87	,5980
88	,92305	—	72,52	167,84	4,68	59,58	,5951
89	,92359	—	73,35	168,63	4,72	59,30	,5924
100 + 90	,92412	—	74,18	169,43	4,75	59,02	,5896
91	,92466	—	75,00	170,22	4,78	58,74	,5868
92	,92519	—	75,83	171,01	4,82	58,47	,5841
93	,92571	—	76,65	171,81	4,84	58,20	,5814
94	,92623	—	77,47	172,60	4,87	57,93	,5787
100 + 95	,92674	—	78,29	173,39	4,90	57,67	,5761
96	,92723	—	79,12	174,18	4,94	57,41	,5735
97	,92772	—	79,94	174,98	4,96	57,15	,5709
98	,92822	—	80,76	175,77	4,99	56,89	,5683
99	,92871	—	81,59	176,57	5,02	56,64	,5657

TABLE II. HEAT 62°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,92920	100	82,42	177,36	5,06	56,38	,5631
99	,92969	—	83,25	178,17	5,08	56,12	,5606
98	,93018	—	84,10	179,co	5,10	55,87	,5580
97	,93066	—	84,94	179,84	5,10	55,60	,5554
96	,93116	—	85,85	180,69	5,16	55,34	,5528
100 + 95	,93164	—	86,75	181,56	5,19	55,08	,5501
94	,93213	—	87,68	182,45	5,23	54,81	,5474
93	,93262	—	88,62	183,37	5,25	54,54	,5447
92	,93311	—	89,58	184,30	5,28	54,26	,5419
91	,93360	—	90,57	185,26	5,31	53,98	,5391
100 + 90	,93411	—	91,58	186,24	5,34	53,70	,5363
89	,93461	—	92,61	187,24	5,37	53,41	,5335
88	,93512	—	93,66	188,26	5,40	53,12	,5306
87	,93564	—	94,74	189,30	5,44	52,82	,5277
86	,93616	—	95,84	190,37	5,47	52,52	,5247
100 + 85	,93669	—	96,97	191,47	5,50	52,22	,5217
84	,93721	—	98,12	192,60	5,52	51,92	,5187
83	,93775	—	99,30	193,75	5,55	51,62	,5156
82	,93830	—	100,51	194,93	5,58	51,31	,5125
81	,93884	—	101,75	196,13	5,62	50,99	,5093
100 + 80	,93940	—	103,02	197,37	5,65	50,67	,5061
79	,93995	—	104,33	198,64	5,69	50,34	,5028
78	,94050	—	105,66	199,94	5,72	50,01	,4996
77	,94105	—	107,03	201,29	5,74	49,68	,4962
76	,94162	—	108,44	202,66	5,78	49,34	,4929
100 + 75	,94218	—	109,89	204,08	5,81	49,00	,4894
74	,94274	—	111,37	205,53	5,84	48,66	,4860
73	,94330	—	112,89	207,03	5,86	48,30	,4825
72	,94388	—	114,46	208,57	5,89	47,95	,4789
71	,94445	—	116,07	210,14	5,93	47,59	,4754
100 + 70	,94302	—	117,74	211,77	5,97	47,22	,4717
69	,94561	—	119,44	213,44	6,00	46,85	,4680
68	,94621	—	121,20	215,16	6,04	46,47	,4643
67	,94681	—	123,01	216,94	6,07	46,10	,4605
66	,94741	—	124,88	218,77	6,11	45,71	,4566
100 + 65	,94801	—	126,80	220,65	6,15	45,32	,4527
64	,94862	—	128,77	222,60	6,17	44,92	,4488
63	,94924	—	130,81	224,61	6,20	44,52	,4447
62	,94985	—	132,92	226,70	6,22	44,11	,4407
61	,95046	—	135,11	228,84	6,27	43,70	,4365
100 + 60	,95109	—	137,37	231,05	6,32	43,28	,4323
59	,95171	—	139,69	233,35	6,34	42,86	,4281
58	,95234	—	142,09	235,72	6,37	42,42	,4238
57	,95297	—	144,59	238,18	6,41	41,98	,4194
56	,95360	—	147,18	240,72	6,46	41,54	,4149
100 + 55	,95423	—	149,85	243,37	6,48	41,09	,4104
54	,95486	—	152,61	246,10	6,51	40,63	,4058
53	,95548	—	155,49	248,96	6,53	40,16	,4012
52	,95610	—	158,48	251,94	6,54	39,69	,3965
51	,95673	—	161,60	255,02	6,58	39,21	,3917

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95737	100	164,84	258,23	6,61	38,72	,3868
49	,95800	—	168,21	261,56	6,65	38,23	,3819
48	,95865	—	171,70	265,04	6,66	37,73	,3769
47	,95929	—	175,35	268,67	6,68	37,22	,3718
46	,95993	—	179,17	272,46	6,71	36,70	,3666
100 + 45	,96058	—	183,16	276,42	6,74	36,17	,3613
44	,96122	—	187,32	280,56	6,76	35,64	,3561
43	,96186	—	191,67	284,90	6,77	35,09	,3506
42	,96250	—	196,23	289,45	6,78	34,54	,3451
41	,96313	—	201,01	294,23	6,78	33,98	,3395
10 + 40	,96378	—	206,05	299,26	6,79	33,41	,3338
39	,96442	—	211,33	304,53	6,80	32,84	,3280
38	,96506	—	216,89	310,10	6,79	32,25	,3221
37	,96570	—	222,75	315,96	6,79	31,65	,3161
36	,96635	—	228,95	322,15	6,80	31,04	,3100
100 + 35	,96698	—	235,48	328,69	6,79	30,42	,3039
34	,96765	—	242,41	335,62	6,79	29,79	,2977
33	,96830	—	249,76	343,00	6,76	29,15	,2913
32	,96895	—	257,56	350,82	6,74	28,50	,2847
31	,96962	—	265,87	359,15	6,72	27,84	,2781
100 + 30	,97028	—	274,73	368,03	6,70	27,17	,2714
29	,97095	—	284,20	377,52	6,68	26,49	,2646
28	,97163	—	294,36	387,70	6,66	25,79	,2576
27	,97231	—	305,26	398,65	6,61	25,09	,2506
26	,97299	—	317,00	410,42	6,58	24,37	,2434
100 + 25	,97369	—	329,68	423,16	6,52	23,63	,2360
24	,97440	—	343,41	436,95	6,46	22,88	,2286
23	,97513	—	358,35	451,95	6,40	22,13	,2210
22	,97586	—	374,64	468,26	6,38	21,35	,2133
21	,97662	—	392,48	486,18	6,30	20,57	,2054
100 + 20	,97740	—	412,10	505,87	6,23	19,77	,1974
19	,97816	—	433,79	527,64	6,15	18,95	,1893
18	,97895	—	457,89	551,82	6,07	18,12	,1810
17	,97977	—	484,83	578,84	5,99	17,28	,1726
16	,98061	—	515,12	609,24	5,88	16,42	,1640
100 + 15	,98148	—	549,47	643,69	5,78	15,54	,1552
14	,98237	—	588,72	683,06	5,66	14,64	,1463
13	,98330	—	634,00	728,44	5,56	13,73	,1371
12	,98427	—	686,84	781,41	5,43	12,80	,1278
11	,98526	—	749,28	843,98	5,30	11,85	,1184
100 + 10	,98630	—	824,20	919,03	5,17	10,88	,1087
9	,98738	—	915,79	1010,76	5,03	9,89	,0987
8	,98851	—	1030,26	1125,38	4,88	8,88	,0888
7	,98970	—	1177,44	1272,72	4,72	7,86	,0785
6	,99094	—	1373,68	1469,12	4,56	6,81	,0680
100 + 5	,99224	—	1648,42	1744,03	4,39	5,73	,0573
4	,99361	—	2060,52	2156,29	4,23	4,64	,0463
3	,99505	—	2747,35	2843,29	4,06	3,52	,0351
2	,99656	—	4121,03	4217,12	3,91	2,37	,0237
1	,99815	—	8242,06	8338,30	3,76	1,20	,0120

TABLE I. HEAT 63°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82357	100	—	100,00	—	100,00	,9983
1	,82589	—	0,82	100,72	0,10	99,29	,9912
2	,82815	—	1,65	101,44	0,21	98,58	,9842
3	,83035	—	2,47	102,16	0,31	97,88	,9772
4	,83250	—	3,30	102,89	0,41	97,19	,9703
100 + 5	,83457	—	4,12	103,62	0,50	96,51	,9634
6	,83661	—	4,94	104,35	0,59	95,83	,9567
7	,83860	—	5,77	105,09	0,68	95,16	,9501
8	,84054	—	6,59	105,83	0,76	94,50	,9435
9	,84243	—	7,42	106,57	0,85	93,84	,9369
100 + 10	,84426	—	8,24	107,31	0,93	93,19	,9304
11	,84607	—	9,06	108,05	1,01	92,55	,9240
12	,84783	—	9,89	108,80	1,09	91,91	,9176
13	,84955	—	10,71	109,55	1,16	91,28	,9113
14	,85124	—	11,53	110,30	1,23	90,66	,9051
100 + 15	,85288	—	12,35	111,05	1,30	90,05	,8990
16	,85451	—	13,18	111,80	1,38	89,44	,8929
17	,85609	—	14,00	112,56	1,44	88,85	,8869
18	,85766	—	14,82	113,31	1,51	88,25	,8810
19	,85919	—	15,65	114,07	1,58	87,66	,8752
100 + 20	,86069	—	16,47	114,83	1,64	87,08	,8694
21	,86217	—	17,29	115,58	1,71	86,51	,8637
22	,86361	—	18,12	116,34	1,78	85,95	,8580
23	,86503	—	18,95	117,10	1,85	85,39	,8525
24	,86642	—	19,77	117,87	1,90	84,84	,8470
100 + 25	,86779	—	20,60	118,63	1,97	84,29	,8415
26	,86914	—	21,42	119,39	2,03	83,75	,8361
27	,87045	—	22,24	120,16	2,08	83,22	,8307
28	,87176	—	23,07	120,92	2,15	82,69	,8255
29	,87304	—	23,89	121,69	2,20	82,17	,8203
100 + 30	,87430	—	24,71	122,46	2,25	81,66	,8152
31	,87553	—	25,53	123,22	2,31	81,15	,8102
32	,87676	—	26,36	123,99	2,37	80,65	,8051
33	,87797	—	27,18	124,76	2,42	80,15	,8002
34	,87915	—	28,01	125,53	2,48	79,66	,7953
100 + 35	,88030	—	28,83	126,30	2,53	79,17	,7904
36	,88145	—	29,66	127,07	2,59	78,69	,7856
37	,88257	—	30,48	127,84	2,64	78,22	,7809
38	,88367	—	31,30	128,62	2,68	77,75	,7762
39	,88475	—	32,13	129,39	2,74	77,29	,7715
100 + 40	,88582	—	32,95	130,17	2,78	76,83	,7669
41	,88688	—	33,77	130,94	2,83	76,37	,7624
42	,88793	—	34,60	131,71	2,89	75,92	,7580
43	,88896	—	35,42	132,48	2,94	75,48	,7536
44	,88998	—	36,25	133,26	2,99	75,04	,7492
100 + 45	,89096	—	37,07	134,03	3,04	74,61	,7448
46	,89195	—	37,89	134,81	3,08	74,18	,7405
47	,89292	—	38,71	135,58	3,13	73,75	,7363
48	,89386	—	39,54	136,36	3,18	73,33	,7321
49	,89479	—	40,36	137,14	3,22	72,92	,7279

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89571	100	41,19	137,92	3,27	72,51	,7238
51	,89661	—	42,01	138,70	3,31	72,10	,7198
52	,89750	—	42,84	139,48	3,36	71,69	,7158
53	,89838	—	43,66	140,26	3,40	71,29	,7117
54	,89924	—	44,48	141,04	3,44	70,90	,7078
100 + 55	,90010	—	45,31	141,82	3,49	70,51	,7039
56	,90094	—	46,13	142,60	3,53	70,13	,7001
57	,90177	—	46,95	143,38	3,57	69,74	,6962
58	,90258	—	47,78	144,17	3,61	69,36	,6924
59	,90337	—	48,60	144 95	3,65	68,99	,6886
100 + 60	,90416	—	49,42	145,73	3,69	68,62	,6850
61	,90494	—	50,24	146,52	3,72	68,25	,6813
62	,90571	—	51,07	147,31	3,76	67,89	,6777
63	,90646	—	51,89	148,09	3,80	67,53	,6741
64	,90721	—	52,72	148,87	3,85	67,17	,6705
100 + 65	,90795	—	53,54	149,66	3,88	66,82	,6670
66	,90869	—	54,37	150,45	3,92	66,47	,6636
67	,90941	—	55,19	151,23	3,96	66,12	,6601
68	,91014	—	56,02	152,02	4,00	65,78	,6567
69	,91085	—	56,84	152,80	4,04	65,44	,6533
100 + 70	,91154	—	57,66	153,59	4,07	65,11	,6500
71	,91224	—	58,48	154,38	4,10	64,78	,6467
72	,91291	—	59,31	155,17	4,14	64,45	,6434
73	,91358	—	60,13	155,95	4,18	64,12	,6401
74	,91425	—	60,96	156,74	4,22	63,80	,6369
100 + 75	,91488	—	61,78	157,53	4,25	63,48	,6337
76	,91554	—	62,61	158,32	4,29	63,16	,6305
77	,91616	—	63,43	159,11	4,32	62,85	,6274
78	,91679	—	64,26	159 90	4,36	62,54	,6243
79	,91742	—	65,08	160,69	4,39	62,23	,6212
100 + 80	,91803	—	65,90	161,48	4,42	61,93	,6182
81	,91863	—	66,72	162,27	4,45	61,63	,6152
82	,91922	—	67,55	163,06	4,49	61,33	,6122
83	,91981	—	68,37	163,85	4,52	61,03	,6092
84	,92039	—	69,19	164,65	4,54	60,74	,6063
100 + 85	,92096	—	70,02	165,44	4,58	60,45	,6034
86	,92152	—	70,84	166,23	4,61	60,16	,6005
87	,92207	—	71,67	167,03	4,64	59,87	,5977
88	,92262	—	72,49	167,82	4,67	59,59	,5949
89	,92316	—	73,32	168,61	4,71	59,31	,5921
100 + 90	,92369	—	74,14	169,41	4,73	59,03	,5893
91	,92423	—	74,96	170,20	4,76	58,75	,5866
92	,92476	—	75,79	170,99	4,80	58,48	,5838
93	,92528	—	76,61	171,79	4,82	58,21	,5811
94	,92580	—	77,43	172,58	4,85	57,94	,5785
100 + 95	,92632	—	78,25	173,37	4,88	57,68	,5758
96	,92681	—	79,08	174,15	4,93	57,42	,5732
97	,92730	—	79,90	174,95	4,95	57,16	,5706
98	,92780	—	80,72	175,75	4,97	56,90	,5681
99	,92829	—	81,55	176,55	5,00	56,64	,5655

TABLE II. HEAT 63°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,92878	100	82,38	177,34	5,04	56,38	,5629
99	,92928	—	83,21	178,15	5,06	56,13	,5604
98	,92976	—	84,06	178,97	5,09	55,87	,5578
97	,93025	—	84,90	179,81	5,09	55,61	,5552
96	,93074	—	85,81	180,66	5,15	55,35	,5526
100 + 95	,93122	—	86,71	181,54	5,17	55,08	,5499
94	,93172	—	87,64	182,42	5,22	54,81	,5472
93	,93220	—	88,58	183,34	5,24	54,54	,5445
92	,93269	—	89,54	184,27	5,27	54,26	,5417
91	,93318	—	90,52	185,24	5,28	53,99	,5389
100 + 90	,93369	—	91,53	186,21	5,32	53,70	,5361
89	,93419	—	92,56	187,21	5,35	53,41	,5333
88	,93471	—	93,61	188,23	5,38	53,12	,5304
87	,93523	—	94,69	189,27	5,42	52,83	,5275
86	,93575	—	95,79	190,35	5,44	52,53	,5245
100 + 85	,93628	—	96,92	191,45	5,47	52,23	,5215
84	,93681	—	98,07	192,57	5,50	51,93	,5185
83	,93735	—	99,25	193,72	5,53	51,62	,5154
82	,93790	—	100,46	194,90	5,56	51,31	,5123
81	,93845	—	101,70	196,10	5,60	50,99	,5091
100 + 80	,93900	—	102,97	197,34	5,63	50,67	,5059
79	,93956	—	104,28	198,61	5,67	50,35	,5026
78	,94011	—	105,61	199,91	5,70	50,02	,4994
77	,94066	—	106,98	201,26	5,72	49,69	,4960
76	,94123	—	108,39	202,63	5,76	49,35	,4927
100 + 75	,94178	—	109,83	204,05	5,78	49,01	,4892
74	,94235	—	111,31	205,50	5,81	48,66	,4858
73	,94291	—	112,83	206,99	5,84	48,31	,4823
72	,94349	—	114,41	208,54	5,87	47,95	,4787
71	,94406	—	116,01	210,11	5,90	47,60	,4752
100 + 70	,94364	—	117,68	211,73	5,95	47,23	,4715
69	,94523	—	119,38	213,40	5,98	46,86	,4678
68	,94583	—	121,14	215,12	6,02	46,48	,4641
67	,94643	—	122,95	216,90	6,05	46,10	,4603
66	,94703	—	124,82	218,73	6,09	45,72	,4564
100 + 65	,94763	—	126,74	220,61	6,13	45,33	,4525
64	,94825	—	128,71	222,56	6,15	44,93	,4486
63	,94887	—	130,75	224,57	6,18	44,53	,4445
62	,94948	—	132,86	226,65	6,21	44,12	,4405
61	,95010	—	135,05	228,79	6,26	43,71	,4363
100 + 60	,95073	—	137,30	231,00	6,30	43,29	,4321
59	,95135	—	139,62	233,30	6,32	42,87	,4279
58	,95198	—	142,02	235,67	6,35	42,43	,4236
57	,95261	—	144,52	238,13	6,39	41,99	,4192
56	,95325	—	147,11	240,67	6,44	41,55	,4148
100 + 55	,95388	—	149,78	243,32	6,46	41,09	,4103
54	,95451	—	152,53	246,05	6,48	40,64	,4057
53	,95513	—	155,41	248,90	6,51	40,17	,4011
52	,95576	—	158,40	251,88	6,52	39,70	,3964
51	,95639	—	161,52	254,96	6,56	39,22	,3916

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95703	100	164,76	258,17	6,59	38,73	,3867
49	,95767	—	168,13	261,50	6,63	38,24	,3818
48	,95832	—	171,62	264,98	6,64	37,74	,3768
47	,95896	—	175,27	268,61	6,66	37,23	,3717
46	,95961	—	179,09	272,40	6,69	36,71	,3665
100 + 45	,96026	—	183,07	276,36	6,71	36,18	,3612
44	,96090	—	187,23	280,49	6,74	35,65	,3560
43	,96155	—	191,58	284,83	6,75	35,11	,3505
42	,96219	—	196,14	289,38	6,76	34,55	,3450
41	,96283	—	200,92	294,15	6,77	33,99	,3394
100 + 40	,96348	—	205,95	299,18	6,77	33,42	,3337
39	,96413	—	211,23	304,45	6,78	32,85	,3279
38	,96477	—	216,79	310,01	6,78	32,26	,3220
37	,96542	—	222,64	315,87	6,77	31,66	,3161
36	,96608	—	228,84	322,05	6,79	31,05	,3100
100 + 35	,96672	—	235,37	328,59	6,78	30,43	,3038
34	,96739	—	242,30	335,52	6,78	29,80	,2976
33	,96805	—	249,64	342,90	6,74	29,16	,2912
32	,96871	—	257,44	350,72	6,72	28,51	,2847
31	,96938	—	265,74	359,03	6,71	27,85	,2781
100 + 30	,97005	—	274,60	367,90	6,70	27,18	,2714
29	,97073	—	284,06	377,39	6,67	26,50	,2645
28	,97141	—	294,22	387,56	6,66	25,80	,2575
27	,97210	—	305,11	398,50	6,61	25,10	,2505
26	,97278	—	316,85	410,27	6,58	24,38	,2433
100 + 25	,97349	—	329,52	423,00	6,52	23,64	,2360
24	,97421	—	343,25	436,78	6,47	22,89	,2286
23	,97494	—	358,18	451,77	6,41	22,13	,2210
22	,97568	—	374,46	468,08	6,38	21,36	,2133
21	,97645	—	392,29	485,98	6,31	20,58	,2054
100 + 20	,97723	—	411,90	505,66	6,24	19,77	,1974
19	,97800	—	433,58	527,42	6,16	18,96	,1893
18	,97879	—	457,67	551,59	6,08	18,13	,1810
17	,97962	—	484,60	578,59	6,01	17,29	,1725
16	,98047	—	514,88	608,98	5,90	16,43	,1639
100 + 15	,98134	—	549,21	643,41	5,80	15,55	,1552
14	,98223	—	588,44	682,76	5,68	14,65	,1463
13	,98317	—	633,70	728,12	5,58	13,74	,1371
12	,98414	—	686,51	781,06	5,45	12,80	,1278
11	,98514	—	748,92	843,60	5,32	11,85	,1183
100 + 10	,98618	—	823,81	918,61	5,20	10,88	,1087
9	,98726	—	915,35	1010,29	5,06	9,90	,0988
8	,98840	—	1029,77	1124,86	4,91	8,89	,0888
7	,98960	—	1176,88	1272,12	4,76	7,86	,0785
6	,99084	—	1373,02	1468,42	4,60	6,81	,0680
100 + 5	,99214	—	1647,63	1743,20	4,43	5,73	,0573
4	,99351	—	2059,53	2155,26	4,27	4,64	,0463
3	,99495	—	2746,03	2841,93	4,10	3,52	,0351
2	,99646	—	4119,06	4215,10	3,96	2,37	,0237
1	,99805	—	8238,12	8334,30	3,82	1,20	,0120

TABLE I. HEAT 64°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82310	100	—	100,00	—	100,00	,9977
1	,82541	—	0,82	100,72	0,10	99,29	,9906
2	,82767	—	1,65	101,44	0,21	98,58	,9836
3	,82987	—	2,47	102,16	0,31	97,88	,9766
4	,83202	—	3,29	102,89	0,40	97,19	,9698
100 + 5	,83409	—	4,11	103,62	0,49	96,51	,9629
6	,83614	—	4,94	104,35	0,59	95,83	,9562
7	,83813	—	5,77	105,09	0,68	95,17	,9495
8	,84007	—	6,59	105,82	0,77	94,50	,9429
9	,84196	—	7,41	106,56	0,85	93,84	,9363
100 + 10	,84379	—	8,24	107,30	0,94	93,20	,9298
11	,84560	—	9,06	108,05	1,01	92,56	,9234
12	,84736	—	9,88	108,79	1,09	91,92	,9171
13	,84908	—	10,70	109,55	1,15	91,29	,9108
14	,85076	—	11,52	110,29	1,23	90,67	,9046
100 + 15	,85241	—	12,35	111,05	1,30	90,05	,8985
16	,85403	—	13,17	111,80	1,37	89,45	,8924
17	,85562	—	14,00	112,56	1,44	88,85	,8864
18	,85719	—	14,82	113,31	1,51	88,26	,8805
19	,85872	—	15,64	114,07	1,57	87,67	,8747
100 + 20	,86022	—	16,46	114,82	1,64	87,09	,8689
21	,86170	—	17,29	115,58	1,71	86,52	,8632
22	,86314	—	18,11	116,34	1,77	85,95	,8576
23	,86456	—	18,94	117,10	1,84	85,39	,8521
24	,86596	—	19,76	117,86	1,90	84,84	,8465
100 + 25	,86732	—	20,59	118,63	1,96	84,29	,8410
26	,86868	—	21,41	119,39	2,02	83,76	,8356
27	,86999	—	22,23	120,16	2,07	83,23	,8303
28	,87130	—	23,06	120,92	2,14	82,70	,8250
29	,87258	—	23,88	121,69	2,19	82,17	,8198
100 + 30	,87384	—	24,70	122,46	2,24	81,66	,8148
31	,87507	—	25,52	123,22	2,30	81,16	,8097
32	,87630	—	26,35	123,99	2,36	80,66	,8047
33	,87751	—	27,17	124,76	2,41	80,16	,7998
34	,87869	—	27,99	125,53	2,46	79,66	,7949
100 + 35	,87984	—	28,82	126,30	2,52	79,17	,7900
36	,88099	—	29,64	127,07	2,57	78,69	,7852
37	,88211	—	30,46	127,83	2,63	78,22	,7805
38	,88321	—	31,29	128,61	2,68	77,75	,7758
39	,88429	—	32,11	129,38	2,73	77,29	,7711
100 + 40	,88536	—	32,93	130,16	2,77	76,83	,7666
41	,88642	—	33,76	130,93	2,83	76,37	,7620
42	,88747	—	34,59	131,70	2,89	75,92	,7576
43	,88850	—	35,41	132,47	2,94	75,49	,7532
44	,88952	—	36,23	133,25	2,98	75,04	,7488
100 + 45	,89051	—	37,06	134,02	3,04	74,61	,7444
46	,89150	—	37,87	134,80	3,07	74,18	,7401
47	,89246	—	38,69	135,57	3,12	73,76	,7359
48	,89340	—	39,52	136,35	3,17	73,34	,7317
49	,89433	—	40,34	137,13	3,21	72,92	,7275

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89525	100	41,17	137,91	3,26	72,51	,7235
51	,89616	—	41,99	138,69	3,30	72,10	,7194
52	,89705	—	42,82	139,47	3,35	71,70	,7154
53	,89793	—	43,64	140,25	3,39	71,30	,7114
54	,89879	—	44,46	141,03	3,43	70,91	,7075
100 + 55	,89965	—	45,29	141,81	3,48	70,51	,7035
56	,90049	—	46,11	142,59	3,52	70,13	,6997
57	,90132	—	46,93	143,37	3,56	69,74	,6958
58	,90214	—	47,76	144,16	3,60	69,36	,6921
59	,90293	—	48,58	144,94	3,64	68,99	,6883
100 + 60	,90372	—	49,40	145,72	3,68	68,63	,6846
61	,90450	—	50,22	146,51	3,71	68,26	,6809
62	,90527	—	51,05	147,29	3,76	67,89	,6773
63	,90602	—	51,87	148,08	3,79	67,54	,6738
64	,90677	—	52,69	148,86	3,83	67,18	,6702
100 + 65	,90751	—	53,52	149,65	3,87	66,82	,6667
66	,90825	—	54,34	150,43	3,91	66,47	,6632
67	,90897	—	55,16	151,22	3,94	66,12	,6598
68	,90970	—	55,99	152,00	3,99	65,78	,6564
69	,91041	—	56,81	152,79	4,02	65,45	,6530
100 + 70	,91110	—	57,63	153,58	4,05	65,11	,6496
71	,91180	—	58,45	154,36	4,09	64,78	,6464
72	,91247	—	59,28	155,15	4,13	64,45	,6431
73	,91314	—	60,10	155,94	4,16	64,12	,6398
74	,91380	—	60,93	156,73	4,20	63,80	,6366
100 + 75	,91444	—	61,75	157,51	4,24	63,48	,6334
76	,91510	—	62,58	158,31	4,27	63,17	,6302
77	,91572	—	63,40	159,09	4,31	62,85	,6271
78	,91635	—	64,23	159,88	4,35	62,54	,6240
79	,91698	—	65,05	160,68	4,37	62,23	,6209
100 + 80	,91759	—	65,87	161,46	4,41	61,93	,6179
81	,91819	—	66,69	162,25	4,44	61,63	,6149
82	,91879	—	67,52	163,04	4,48	61,33	,6119
83	,91938	—	68,34	163,84	4,50	61,03	,6089
84	,91996	—	69,16	164,63	4,53	60,74	,6060
100 + 85	,92053	—	69,99	165,42	4,57	60,45	,6031
86	,92109	—	70,81	166,21	4,60	60,16	,6002
87	,92164	—	71,64	167,01	4,63	59,88	,5974
88	,92219	—	72,46	167,80	4,66	59,60	,5946
89	,92273	—	73,28	168,60	4,68	59,31	,5918
100 + 90	,92326	—	74,11	169,39	4,72	59,03	,5890
91	,92380	—	74,93	170,18	4,75	58,76	,5863
92	,92433	—	75,76	170,97	4,79	58,49	,5836
93	,92485	—	76,57	171,77	4,80	58,22	,5808
94	,92537	—	77,39	172,56	4,83	57,95	,5782
100 + 95	,92589	—	78,21	173,35	4,86	57,68	,5755
96	,92639	—	79,04	174,13	4,91	57,42	,5730
97	,92688	—	79,86	174,93	4,93	57,16	,5704
98	,92738	—	80,68	175,72	4,96	56,90	,5678
99	,92787	—	81,51	176,52	4,99	56,65	,5652

TABLE II. HEAT 64°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,92836	100	82,34	177,32	5,02	56,39	,5626
99	,92886	—	83,17	178,13	5,04	56,13	,5601
98	,92935	—	84,02	178,95	5,07	55,88	,5576
97	,92983	—	84,87	179,79	5,08	55,62	,5549
96	,93033	—	85,77	180,64	5,13	55,35	,5523
100 + 95	,93081	—	86,67	181,51	5,16	55,09	,5497
94	,93130	—	87,60	182,40	5,20	54,82	,5469
93	,93179	—	88,54	183,32	5,22	54,55	,5442
92	,93228	—	89,50	184,25	5,25	54,27	,5414
91	,93277	—	90,48	185,21	5,27	53,99	,5386
100 + 90	,93327	—	91,49	186,19	5,30	53,71	,5358
89	,93378	—	92,51	187,19	5,32	53,42	,5331
88	,93430	—	93,56	188,20	5,36	53,13	,5302
87	,93482	—	94,64	189,25	5,39	52,84	,5273
86	,93534	—	95,75	190,32	5,43	52,54	,5243
100 + 85	,93587	—	96,87	191,42	5,45	52,24	,5212
84	,93641	—	98,03	192,54	5,49	51,94	,5182
83	,93695	—	99,21	193,69	5,52	51,63	,5152
82	,93750	—	100,41	194,87	5,54	51,32	,5121
81	,93806	—	101,65	196,07	5,58	51,00	,5089
100 + 80	,93861	—	102,92	197,31	5,61	50,68	,5056
79	,93917	—	104,23	198,58	5,65	50,36	,5024
78	,93972	—	105,56	199,88	5,68	50,03	,4992
77	,94027	—	106,93	201,23	5,70	49,69	,4958
76	,94183	—	108,34	202,60	5,74	49,35	,4925
100 + 75	,94139	—	109,78	204,01	5,77	49,01	,4890
74	,94196	—	111,26	205,47	5,79	48,67	,4856
73	,94252	—	112,78	206,95	5,83	48,32	,4821
72	,94310	—	114,35	208,50	5,85	47,96	,4785
71	,94368	—	115,96	210,08	5,88	47,61	,4750
100 + 70	,94326	—	117,62	211,70	5,92	47,24	,4713
69	,94485	—	119,32	213,36	5,96	46,87	,4676
68	,94545	—	121,08	215,08	6,00	46,49	,4639
67	,94605	—	122,89	216,86	6,03	46,11	,4601
66	,94666	—	124,76	218,69	6,07	45,73	,4562
100 + 65	,94725	—	126,68	220,57	6,11	45,34	,4523
64	,94788	—	128,65	222,51	6,14	44,94	,4484
63	,94850	—	130,69	224,52	6,17	44,54	,4444
62	,94912	—	132,80	226,61	6,19	44,13	,4403
61	,94974	—	134,98	228,74	6,24	43,72	,4362
100 + 60	,95037	—	137,23	230,96	6,27	43,30	,4320
59	,95099	—	139,55	233,25	6,30	42,87	,4277
58	,95162	—	141,95	235,62	6,33	42,44	,4234
57	,95226	—	144,45	238,08	6,37	42,00	,4190
56	,95290	—	147,04	240,62	6,42	41,56	,4146
100 + 55	,95353	—	149,71	243,27	6,44	41,10	,4101
54	,95416	—	152,45	246,00	6,45	40,65	,4055
53	,95479	—	155,33	248,85	6,48	40,18	,4010
52	,95542	—	158,32	251,82	6,50	39,71	,3963
51	,95605	—	161,44	254,90	6,54	39,23	,3915

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95669	100	164,68	258,11	6,57	38,74	,3865
49	,95734	—	168,05	261,44	6,61	38,25	,3816
48	,95799	—	171,54	264,92	6,62	37,75	,3767
47	,95863	—	175,19	268,55	6,64	37,24	,3716
46	,95929	—	179,00	272,33	6,67	36,72	,3664
100 + 45	,95994	—	182,98	276,29	6,69	36,19	,3611
44	,96059	—	187,14	280,42	6,72	35,66	,3558
43	,96124	—	191,49	284,76	6,73	35,11	,3504
42	,96188	—	196,15	289,31	6,74	34,56	,3449
41	,96253	—	200,83	294,08	6,75	34,00	,3393
100 + 40	,96318	—	205,85	299,10	6,75	33,43	,3336
39	,96384	—	211,13	304,37	6,76	32,86	,3278
38	,96449	—	216,69	309,92	6,77	32,27	,3219
37	,96514	—	222,54	315,77	6,77	31,67	,3160
36	,96581	—	228,73	321,95	6,78	31,06	,3099
100 + 35	,96646	—	235,26	328,49	6,77	30,44	,3037
34	,96713	—	242,18	335,42	6,76	29,81	,2975
33	,96780	—	249,52	342,80	6,72	29,17	,2911
32	,96847	—	257,32	350,61	6,71	28,52	,2846
31	,96914	—	265,61	358,92	6,69	27,86	,2780
100 + 30	,96982	—	274,47	367,78	6,69	27,19	,2713
29	,97051	—	283,93	377,26	6,67	26,51	,2645
28	,97119	—	294,08	387,42	6,66	25,81	,2575
27	,97189	—	304,97	398,36	6,61	25,11	,2505
26	,97258	—	316,70	410,12	6,58	24,39	,2433
100 + 25	,97329	—	329,36	422,84	6,52	23,65	,2360
24	,97402	—	343,09	436,61	6,48	22,90	,2286
23	,97475	—	358,01	451,59	6,42	21,14	,2210
22	,97550	—	374,28	467,90	6,38	21,37	,2132
21	,97628	—	392,10	485,79	6,31	20,58	,2054
100 + 20	,97706	—	411,71	505,45	6,26	19,78	,1974
19	,97784	—	433,37	527,20	6,17	18,97	,1892
18	,97864	—	457,45	551,36	6,09	18,14	,1809
17	,97947	—	484,37	578,35	6,02	17,29	,1725
16	,98033	—	514,64	608,72	5,92	16,43	,1639
100 + 15	,98120	—	548,95	643,13	5,82	15,55	,1551
14	,98210	—	588,16	682,46	5,70	14,65	,1462
13	,98304	—	633,40	727,80	5,60	13,74	,1371
12	,98401	—	686,18	780,71	5,47	12,81	,1278
11	,98502	—	748,56	843,22	5,34	11,86	,1183
100 + 10	,98606	—	823,42	918,19	5,23	10,89	,1087
9	,98715	—	914,91	1009,83	5,08	9,90	,0988
8	,98829	—	1029,28	1124,34	4,94	8,89	,0887
7	,98950	—	1176,32	1271,52	4,80	7,86	,0785
6	,99074	—	1372,37	1467,73	4,64	6,81	,0680
100 + 5	,99204	—	1646,84	1742,37	4,47	5,74	,0573
4	99341	—	2058,55	2154,24	4,31	4,64	,0463
3	,99485	—	2744,72	2840,58	4,14	3,52	,0351
2	,99636	—	4117,09	4213,09	4,00	2,37	,0237
1	,99795	—	8234,20	8330,33	3,87	1,20	,0120

TABLE I. HEAT 65°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82262	100	—	100,00	—	100,00	,9971
1	,82493	—	0,82	100,72	0,10	99,29	,9900
2	,82719	—	1,65	101,44	0,21	98,58	,9830
3	,82939	—	2,47	102,16	0,31	97,88	,9760
4	,83154	—	3,29	102,89	0,40	97,19	,9691
100 + 5	,83362	—	4,11	103,62	0,49	96,51	,9623
6	,83566	—	4,94	104,35	0,59	95,84	,9556
7	,83765	—	5,76	105,08	0,68	95,17	,9489
8	,83960	—	6,58	105,82	0,76	94,50	,9423
9	,84150	—	7,41	106,56	0,85	93,85	,9358
100 + 10	,84334	—	8,23	107,30	0,93	93,20	,9293
11	,84513	—	9,05	108,04	1,01	92,56	,9229
12	,84689	—	9,88	108,79	1,09	91,92	,9166
13	,84861	—	10,70	109,54	1,16	91,29	,9103
14	,85029	—	11,52	110,29	1,23	90,67	,9041
100 + 15	,85193	—	12,34	111,04	1,30	90,05	,8980
16	,85355	—	13,17	111,79	1,38	89,45	,8919
17	,85515	—	13,99	112,55	1,44	88,85	,8859
18	,85672	—	14,81	113,30	1,51	88,26	,8800
19	,85826	—	15,64	114,06	1,58	87,67	,8742
100 + 20	,85976	—	16,46	114,82	1,64	87,09	,8684
21	,86123	—	17,28	115,57	1,71	86,52	,8627
22	,86268	—	18,10	116,33	1,77	85,96	,8571
23	,86410	—	18,93	117,09	1,84	85,40	,8515
24	,86549	—	19,75	117,86	1,89	84,85	,8460
100 + 25	,86686	—	20,58	118,62	1,96	84,30	,8406
26	,86821	—	21,40	119,38	2,02	83,76	,8352
27	,86953	—	22,22	120,15	2,07	83,23	,8299
28	,87083	—	23,05	120,91	2,14	82,70	,8246
29	,87211	—	23,87	121,68	2,19	82,18	,8194
100 + 30	,87337	—	24,69	122,45	2,24	81,67	,8143
31	,87461	—	25,51	123,21	2,30	81,16	,8092
32	,87583	—	26,34	123,98	2,36	80,66	,8042
33	,87704	—	27,16	124,75	2,41	80,16	,7993
34	,87822	—	27,98	125,52	2,46	79,67	,7944
100 + 35	,87938	—	28,81	126,29	2,52	79,18	,7896
36	,88052	—	29,63	127,06	2,57	78,70	,7848
37	,88164	—	30,45	127,83	2,62	78,23	,7800
38	,88274	—	31,27	128,60	2,67	77,76	,7753
39	,88383	—	32,10	129,37	2,73	77,30	,7707
100 + 40	,88490	—	32,92	130,15	2,77	76,84	,7662
41	,88596	—	33,74	130,92	2,82	76,38	,7616
42	,88701	—	34,57	131,69	2,88	75,93	,7572
43	,88804	—	35,39	132,46	2,93	75,49	,7528
44	,88906	—	36,21	133,24	2,97	75,05	,7484
100 + 45	,89006	—	37,04	134,01	3,03	74,62	,7440
46	,89104	—	37,86	134,79	3,07	74,19	,7397
47	,89201	—	38,68	135,57	3,11	73,76	,7355
48	,89294	—	39,50	136,34	3,16	73,34	,7313
49	,89387	—	40,33	137,12	3,21	72,93	,7272

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89479	100	41,15	137,90	3,25	72,52	,7231
51	,89570	—	41,97	138,68	3,29	72,11	,7190
52	,89659	—	42,80	139,46	3,34	71,70	,7150
53	,89747	—	43,62	140,24	3,38	71,30	,7110
54	,89834	—	44,44	141,02	3,42	70,91	,7071
100 + 55	,89920	—	45,27	141,80	3,47	70,52	,7032
56	,90004	—	46,09	142,58	3,51	70,13	,6993
57	,90087	—	46,91	143,36	3,55	69,75	,6955
58	,90168	—	47,74	144,15	3,59	69,37	,6917
59	,90248	—	48,56	144,93	3,63	69,00	,6880
100 + 60	,90328	—	49,38	145,71	3,67	68,63	,6843
61	,90406	—	50,20	146,50	3,70	68,26	,6806
62	,90483	—	51,03	147,28	3,75	67,90	,6770
63	,90558	—	51,85	148,07	3,78	67,54	,6734
64	,90633	—	52,67	148,85	3,82	67,18	,6698
100 + 65	,90707	—	53,50	149,64	3,86	66,83	,6663
66	,90781	—	54,32	150,42	3,90	66,48	,6628
67	,90853	—	55,14	151,21	3,93	66,13	,6594
68	,90925	—	55,97	151,99	3,98	65,79	,6560
69	,90996	—	56,79	152,78	4,01	65,45	,6526
100 + 70	,91066	—	57,61	153,56	4,05	65,12	,6493
71	,91135	—	58,43	154,35	4,08	64,79	,6460
72	,91202	—	59,26	155,14	4,12	64,46	,6427
73	,91269	—	60,08	155,93	4,15	64,13	,6395
74	,91335	—	60,90	156,72	4,18	63,81	,6363
100 + 75	,91400	—	61,73	157,50	4,23	63,49	,6331
76	,91465	—	62,55	158,29	4,26	63,17	,6299
77	,91528	—	63,37	159,08	4,29	62,86	,6268
78	,91591	—	64,20	159,87	4,33	62,55	,6237
79	,91654	—	65,02	160,66	4,36	62,24	,6206
100 + 80	,91715	—	65,84	161,45	4,39	61,94	,6176
81	,91776	—	66,66	162,24	4,42	61,64	,6146
82	,91835	—	67,49	163,03	4,46	61,34	,6116
83	,91894	—	68,31	163,82	4,49	61,04	,6086
84	,91953	—	69,13	164,61	4,52	60,75	,6057
100 + 85	,92010	—	69,96	165,40	4,56	60,46	,6028
86	,92066	—	70,78	166,19	4,59	60,17	,5999
87	,92121	—	71,61	166,99	4,62	59,89	,5971
88	,92176	—	72,43	167,78	4,65	59,60	,5943
89	,92230	—	73,25	168,58	4,67	59,32	,5915
100 + 90	,92283	—	74,07	169,37	4,70	59,04	,5987
91	,92337	—	74,90	170,16	4,74	58,77	,5860
92	,92390	—	75,72	170,95	4,77	58,50	,5833
93	,92442	—	76,54	171,75	4,79	58,23	,5806
94	,92494	—	77,36	172,54	4,82	57,96	,5779
100 + 95	,92546	—	78,18	173,33	4,85	57,69	,5753
96	,92596	—	79,00	174,11	4,89	57,43	,5727
97	,92646	—	79,82	174,90	4,92	57,17	,5701
98	,92696	—	80,64	175,70	4,94	56,91	,5675
99	,92745	—	81,47	176,50	4,97	56,66	,5649

TABLE II. HEAT 65°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,92794	100	82,30	177,30	5,00	56 40	,5624
99	,92844	—	83,13	178,11	5,01	56,14	,5599
98	,92893	—	83,98	178,93	5,05	55,89	,5574
97	,92942	—	84,84	179,77	5,07	55,63	,5547
96	,92991	—	85.72	180.62	5.10	55,36	,5521
100 + 95	,93040	—	86,63	181,49	5,14	55,10	,5494
94	,93088	—	87,56	182,38	5,18	54,83	,5467
93	,93137	—	88,50	183,29	5,21	54,56	,5440
92	,93186	—	89,46	184,23	5,23	54,28	,5412
91	,93235	—	90,44	185,19	5,25	54.00	,5384
100 + 90	,93285	—	91,45	186,16	5,29	53,72	,5356
89	,93336	—	92,47	187,16	5,31	53,43	,5328
88	,93388	—	93,52	188,18	5,34	53,14	,5299
87	,93440	—	94,60	189,23	5,37	52,84	,5270
86	,93493	—	95,70	190,30	5,40	52,55	,5240
100 + 85	,93546	—	96,83	191,39	5,44	52,25	,5210
84	,93600	—	97,98	192,51	5,47	51,94	,5180
83	,93655	—	99,16	193,66	5,50	51,63	,5149
82	,93710	—	100,37	194,84	5,53	51,32	,5118
81	,93766	—	101,61	196,04	5,57	51,01	,5086
100 + 80	,93822	—	102,88	197,28	5,60	50,69	,5054
79	,93877	—	104,18	198,55	5,63	50,37	,5022
78	,93932	—	105,51	199,85	5,66	50,04	,4989
77	,93987	—	106,88	201,19	5,69	49,70	,4956
76	,94043	—	108,29	202,57	5,72	49,36	,4922
100 + 75	,94099	—	109,73	203,98	5,75	49,02	,4888
74	,94156	—	111,21	205,43	5,78	48,68	,4854
73	,94213	—	112,73	206,92	5,81	48,33	,4819
72	,94271	—	114,30	208,46	5,84	47,97	,4783
71	,94329	—	115,91	210,04	5,87	47,61	,4747
100 + 70	,94388	—	117,57	211,66	5,91	47,25	,4711
69	,94447	—	119,27	213,32	5,95	46,88	,4674
68	,94507	—	121,02	215,04	5,98	46,50	,4637
67	,94567	—	122,83	216,82	6,01	46,12	,4599
66	,94628	—	124,70	218,65	6,05	45,74	,4560
100 + 65	,94689	—	126,62	220,53	6,09	45,35	,4521
64	,94751	—	128,59	222,47	6,12	44,95	,4482
63	,94813	—	130,63	224,48	6,15	44,55	,4442
62	,94875	—	132,74	226,56	6,18	44,14	,4401
61	,94937	—	134,92	228,70	6,22	43,73	,4360
100 + 60	,95000	—	137,17	230,91	6,26	43,31	,4318
59	,95063	—	139,49	233,20	6,29	42,88	,4276
58	,95126	—	141,89	235,57	6,32	42,45	,4233
57	,95190	—	144,38	238,03	6,35	42,01	,4189
56	,95254	—	146,97	240,58	6,39	41,57	,4145
100 + 55	,95318	—	149,64	243,22	6,42	41,11	,4100
54	,95381	—	152,38	245,95	6,43	40,66	,4054
53	,95444	—	155,25	248,80	6,45	40,19	,4008
52	,95507	—	158,24	251,77	6,47	39,72	,3961
51	,95571	—	161,36	254,85	6,51	39,24	,3913

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95635	100	164,61	258,05	6,56	38,75	,3864
49	,95700	—	167,97	261,38	6,59	38,26	,3815
48	,95765	—	171,46	264,86	6,60	37,76	,3765
47	,95830	—	175,11	268,49	6,62	37,25	,3714
46	,95896	—	178,92	272,27	6,65	36,73	,3662
100 + 45	,95962	—	182,90	276,22	6,68	36, 0	,3610
44	,96027	—	187,05	280,35	6,70	35,67	,3557
43	,96092	—	191,40	284,69	6,71	35,12	,3502
42	,96157	—	195,96	289,24	6,72	34,57	,3447
41	,96222	—	200,74	294,01	6,73	34,01	,3392
100 + 40	,96288	—	205,76	299,02	6,74	33,44	,3335
39	,96354	—	211,03	304,29	6,74	32,86	,3277
38	,96420	—	216,59	309,83	6,76	32,28	,3218
37	,96486	—	222,44	315,68	6,76	31,68	,3159
36	,96553	—	228,62	321,85	6,77	31,07	,3098
100 + 35	,96620	—	235,15	328,39	6,76	30,45	,3036
34	,96687	—	242,07	335,32	6,75	29,82	,2974
33	,96754	—	249,40	342,70	6,70	29,18	,2910
32	,96822	—	257,20	350,51	6,69	28,53	,2845
31	,96890	—	265,49	358,81	6,68	27,87	,2779
100 + 30	,96959	—	274,34	367,65	6,69	27,20	,2712
29	,97028	—	283,80	377,13	6,67	26,52	,2644
28	,97097	—	293,94	387,28	6,66	25,82	,2574
27	,97167	—	304,83	398,22	6,61	25,11	,2504
26	,97237	—	316,55	409,97	6,58	24,39	,2432
100 + 25	,97309	—	329,21	422,68	6,53	23,66	,2359
24	,97382	—	342,93	436,45	6,48	22,91	,2285
23	,97456	—	357,84	451,41	6,43	22,15	,2209
22	,97532	—	374,10	467,72	6,38	21,38	,2132
21	,97610	—	391,92	485,60	6,32	20,59	,2053
100 + 20	,97688	—	411,52	505,25	6,27	19,79	,1973
19	,97767	—	433,17	526,99	6,17	18,97	,1892
18	,97848	—	457,24	551,13	6,11	18,14	,1809
17	,97932	—	484,14	578,11	6,03	17,30	,1725
16	,98018	—	514,40	608,46	5,94	16,44	,1639
100 + 15	,98106	—	548,69	642,85	5,84	15,56	,1551
14	,98196	—	587,88	682,16	5,72	14,66	,1462
13	,98290	—	633,10	727,48	5,62	13,75	,1371
12	,98388	—	685,86	780,36	5,50	12,81	,1278
11	,98489	—	748,21	842,84	5,37	11,86	,1183
100 + 10	,98594	—	823,03	917,77	5,26	10,89	,1086
9	,98703	—	914,48	1009,37	5,11	9,91	,0988
8	,98818	—	1028,79	1123,82	4,97	8.90	,0887
7	,98939	—	1175,76	1270,93	4,83	7,87	,0735
6	,99063	—	1371.72	1467,04	4.68	6.82	,0680
100 + 5	,99194	—	1646,06	1741,54	4,52	5,74	,0572
4	,99331	—	2057,58	2153,22	4,36	4,64	,0463
3	,99475	—	2743,44	2839,24	4,20	3,52	,0351
2	,99626	—	4115,15	4211,11	4,04	2,37	,0237
1	,99784	—	8230,31	8326,40	3,91	1,20	,0120

TABLE I. HEAT 66°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82214	100	—	100,00	—	100,00	,9965
1	,82446	—	0,82	100,72	0,10	99,29	,9895
2	,82672	—	1,65	101,44	0,21	98,58	,9825
3	,82892	—	2,47	102,16	0,31	97,88	,9755
4	,83107	—	3,29	102,89	0,40	97,19	,9686
100 + 5	,83315	—	4,11	103,62	0,49	96,51	,9618
6	,83519	—	4,94	104,35	0,59	95,84	,9551
7	,83717	—	5,76	105,08	0,68	95,17	,9484
8	,83912	—	6,58	105,82	0,76	94,50	,9418
9	,84102	—	7,41	106,56	0,85	93,85	,9353
100 + 10	,84286	—	8,23	107,30	0,93	93,20	,9288
11	,84465	—	9,05	108,04	1,01	92,56	,9224
12	,84641	—	9,87	108,79	1,08	91,92	,9160
13	,84813	—	10,69	109,54	1,15	91,29	,9098
14	,84981	—	11,51	110,29	1,22	90,67	,9036
100 + 15	,85145	—	12,34	111,04	1,30	90,05	,8975
16	,85307	—	13,16	111,79	1,37	89,45	,8914
17	,85467	—	13,98	112,55	1,43	88,85	,8854
18	,85624	—	14,80	113,30	1,50	88,26	,8795
19	,85778	—	15,63	114,06	1,57	87,67	,8737
100 + 20	,85928	—	16,45	114,82	1,63	87,09	,8679
21	,86076	—	17,27	115,57	1,70	86,52	,8622
22	,86221	—	18,09	116,33	1,76	85,96	,8566
23	,86363	—	18,92	117,09	1,83	85,40	,8511
24	,86502	—	19,74	117,85	1,89	84,85	,8456
100 + 25	,86639	—	20,57	118,62	1,95	84,30	,8401
26	,86774	—	21,39	119,38	2,01	83,76	,8348
27	,86907	—	22,21	120,14	2,07	83,23	,8295
28	,87037	—	23,04	120,91	2,13	82,70	,8242
29	,87165	—	23,86	121,68	2,18	82,18	,8190
100 + 30	,87291	—	24,68	122,44	2,24	81,67	,8139
31	,87415	—	25,50	123,20	2,30	81,17	,8088
32	,87537	—	26,33	123,97	2,36	80,66	,8038
33	,87658	—	27,15	124,74	2,41	80,16	,7989
34	,87776	—	27,97	125,52	2,45	79,67	,7940
100 + 35	,87892	—	28,80	126,28	2,52	79,18	,7891
36	,88006	—	29,61	127,05	2,56	78,70	,7844
37	,88117	—	30,44	127,82	2,62	78,23	,7796
38	,88227	—	31,26	128,59	2,67	77,76	,7749
39	,88336	—	32,08	129,36	2,72	77,30	,7703
100 + 40	,88443	—	32,90	130,14	2,76	76,84	,7658
41	,88549	—	33,72	130,91	2,81	76,38	,7612
42	,88654	—	34,55	131,68	2,87	75,93	,7568
43	,88758	—	35,37	132,45	2,92	75,50	,7524
44	,88860	—	36,19	133,23	2,96	75,06	,7480
100 + 45	,88959	—	37,02	134,00	3,02	74,62	,7436
46	,89058	—	37,84	134,78	3,06	74,19	,7394
47	,89154	—	38,66	135,56	3,10	73,77	,7352
48	,89249	—	39,48	136,33	3,15	73,35	,7310
49	,89342	—	40,31	137,11	3,20	72,93	,7268

I. Spirit and Water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89433	100	41,13	137,89	3,24	72,52	,7227
51	,89525	—	41,95	138,67	3,28	72,12	,7187
52	,89613	—	42,78	139,45	3,33	71,71	,7147
53	,89702	—	43,60	140,22	3,38	71,31	,7107
54	,89789	—	44,42	141,00	3,42	70,92	,7068
100 + 55	,89875	—	45,24	141,78	3,46	70,53	,7028
56	,89959	—	46,06	142,56	3,50	70,14	,6990
57	,90042	—	46,88	143,35	3,53	69,76	,6952
58	,90124	—	47,71	144,13	3,58	69,38	,6914
59	,90204	—	48,53	144,91	3,62	69,00	,6877
100 + 60	,90284	—	49,35	145,70	3,65	68,64	,6840
61	,90362	—	50,17	146,48	3,69	68,27	,6803
62	,90439	—	51,00	147,26	3,74	67,90	,6767
63	,90514	—	51,82	148,05	3,77	67,54	,6731
64	,90589	—	52,64	148,83	3,81	67,19	,6695
100 + 65	,90663	—	53,47	149,62	3,85	66,84	,6660
66	,90737	—	54,29	150,40	3,89	66,49	,6625
67	,90809	—	55,11	151,19	3,92	66,14	,6591
68	,90881	—	55,94	151,97	3,97	65,79	,6557
69	,90952	—	56,76	152,76	4,00	65,46	,6523
100 + 70	,91023	—	57,58	153,55	4,03	65,13	,6490
71	,91091	—	58,40	154,33	4,07	64,80	,6457
72	,91159	—	59,23	155,12	4,11	64,46	,6424
73	,91225	—	60,05	155,91	4,14	64,13	,6392
74	,91291	—	60,87	156,70	4,17	63,82	,6360
100 + 75	,91356	—	61,70	157,48	4,22	63,50	,6328
76	,91421	—	62,52	158,27	4,25	63,18	,6296
77	,91484	—	63,34	159,06	4,28	62,87	,6265
78	,91547	—	64,16	159,85	4,31	62,56	,6234
79	,91610	—	64,99	160,64	4,35	62,25	,6203
100 + 80	,91670	—	65,81	161,43	4,38	61,95	,6173
81	,91732	—	66,63	162,22	4,41	61,64	,6143
82	,91791	—	67,45	163,01	4,44	61,34	,6113
83	,91851	—	68,27	163,80	4,47	61,05	,6083
84	,91910	—	69,09	164,59	4,50	60,76	,6054
100 + 85	,91967	—	69,92	165,39	4,53	60,46	,6026
86	,92023	—	70,74	166,18	4,56	60,18	,5997
87	,92078	—	71,57	166,97	4,60	59,89	,5969
88	,92133	—	72,39	167,76	4,63	59,61	,5941
89	,92187	—	73,21	168,56	4,65	59,33	,5913
100 + 90	,92241	—	74,03	169,35	4,68	59,05	,5985
91	,92295	—	74,86	170,14	4,72	58,77	,5858
92	,92347	—	75,68	170,93	4,75	58,50	,5831
93	,92400	—	76,50	171,72	4,78	58,23	,5804
94	,92452	—	77,32	172,52	4,80	57,96	,5777
100 + 95	,92504	—	78,14	173,31	4,83	57,70	,5750
96	,92554	—	78,96	174,09	4,87	57,44	,5725
97	,92604	—	79,78	174,88	4,90	57,18	,5699
98	,92654	—	80,60	175,67	4,93	56,92	,5673
99	,92703	—	81,43	176,47	4,96	56,66	,5647

TABLE II. HEAT 66°.

I. Water and Spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,92752	100	82,26	177,27	4,99	56,41	,5621	100 + 50	,95601	100	164,53	257,99	6,54	38,76	,3863
99	,92801	—	83,09	178,08	5,01	56,15	,5596	49	,95667	—	167,89	261,31	6,58	38,27	,3814
98	,92851	—	83,94	178,90	5,04	55,89	,5571	48	,95732	—	171,38	264,79	6,59	37,77	,3764
97	,92900	—	84,80	179,74	5,06	55,63	,5544	47	,95798	—	175,02	268,42	6,60	37,26	,3713
96	,92949	—	85,68	180,59	5,09	55,37	,5518	46	,95864	—	178,83	272,20	6,63	36,73	,3661
100 + 95	,92998	—	86,59	181,46	5,13	55,11	,5492	100 + 45	,95930	—	182,81	276,16	6,65	36,21	,3609
94	,93046	—	87,51	182,35	5,16	54,83	,5465	44	,95996	—	186,96	280,28	6,68	35,67	,3556
93	,93095	—	88,45	183,26	5,19	54,56	,5438	43	,96061	—	191,31	284,61	6,70	35,13	,3501
92	,93144	—	89,41	184,20	5,21	54,28	,5410	42	,96127	—	195,86	289,16	6,70	34,58	,3446
91	,93194	—	90,39	185,16	5,23	54,00	,5382	41	,96193	—	200,64	293,93	6,71	34,02	,3391
100 + 90	,93242	—	91,40	186,13	5,27	53,72	,5354	100 + 40	,96259	—	205,66	298,94	6,72	33,45	,3334
89	,93295	—	92,42	187,13	5,29	53,43	,5326	39	,96325	—	210,93	304,20	6,73	32,87	,3276
88	,93347	—	93,47	188,16	5,31	53,14	,5297	38	,96392	—	216,48	309,74	6,74	32,28	,3217
87	,93399	—	94,55	189,20	5,35	52,85	,5268	37	,96459	—	222,33	315,59	6,74	31,68	,3158
86	,93452	—	95,65	190,27	5,38	52,56	,5238	36	,96526	—	228,51	321,76	6,75	31,07	,3097
100 + 85	,93505	—	96,78	191,36	5,42	52,25	,5207	100 + 35	,96593	—	235,04	328,29	6,75	30,46	,3035
84	,93559	—	97,93	192,49	5,44	51,95	,5178	34	,96661	—	241,95	335,21	6,74	29,83	,2973
83	,93614	—	99,11	193,64	5,47	51,64	,5147	33	,96728	—	249,28	342,59	6,69	29,19	,2909
82	,93669	—	100,32	194,82	5,50	51,33	,5116	32	,96797	—	257,07	350,40	6,67	28,54	,2844
81	,93725	—	101,56	196,02	5,54	51,02	,5084	31	,96865	—	265,36	358,69	6,67	27,88	,2778
100 + 80	,93781	—	102,83	197,25	5,58	50,70	,5052	100 + 30	,96935	—	274,21	367,53	6,68	27,21	,2711
79	,93836	—	104,13	198,52	5,61	50,37	,5020	29	,97004	—	283,66	377,00	6,66	26,52	,2643
78	,93892	—	105,46	199,82	5,64	50,04	,4987	28	,97074	—	293,80	387,15	6,65	25,83	,2574
77	,93947	—	106,83	201,16	5,67	49,71	,4954	27	,97145	—	304,68	398,09	6,59	25,12	,2504
76	,94003	—	108,24	202,54	5,70	49,37	,4920	26	,97216	—	316,40	409,83	6,57	24,40	,2432
100 + 75	,94058	—	109,68	203,95	5,73	49,03	,4886	100 + 25	,97288	—	329,05	422,52	6,53	23,67	,2359
74	,94116	—	111,15	205,40	5,75	48,69	,4852	24	,97362	—	342,76	436,28	6,48	22,92	,2285
73	,94174	—	112,67	206,88	5,79	48,34	,4817	23	,97436	—	357,67	451,24	6,43	22,16	,2209
72	,94232	—	114,24	208,43	5,81	47,98	,4782	22	,97513	—	373,92	467,54	6,38	21,39	,2132
71	,94290	—	115,85	210,00	5,85	47,62	,4746	21	,97591	—	391,73	485,41	6,32	20,60	,2053
100 + 70	,94349	—	117,51	211,62	5,89	47,26	,4709	100 + 20	,97670	—	411,32	505,05	6,27	19,80	,1973
69	,94409	—	119,21	213,28	5,93	46,89	,4672	19	,97750	—	432,96	526,78	6,18	18,98	,1892
68	,94469	—	120,96	215,00	5,96	46,51	,4635	18	,97831	—	457,02	550,90	6,12	18,15	,1809
67	,94529	—	122,77	216,78	5,99	46,13	,4597	17	,97916	—	483,91	577,87	6,04	17,31	,1725
66	,94590	—	124,64	218,61	6,03	45,75	,4559	16	,98002	—	514,15	608,20	5,95	16,45	,1639
100 + 65	,94652	—	126,56	220,49	6,07	45,35	,4520	100 + 15	,98091	—	548,43	642,57	5,86	15,57	,1551
64	,94714	—	128,53	222,43	6,10	44,95	,4480	14	,98181	—	587,60	681,86	5,74	14,67	,1462
63	,94776	—	130,56	224,44	6,12	44,56	,4441	13	,98276	—	632,80	727,16	5,64	13,75	,1371
62	,94838	—	132,67	226,51	6,16	44,15	,4400	12	,98374	—	685,53	780,01	5,52	12,82	,1278
61	,94900	—	134,85	228,65	6,20	43,74	,4359	11	,98476	—	747,85	842,46	5,39	11,87	,1183
100 + 60	,94963	—	137,10	230,86	6,24	43,32	,4317	100 + 10	,98580	—	822,64	917,36	5,28	10,90	,1086
59	,95026	—	139,42	233,16	6,26	42,89	,4275	9	,98690	—	914,05	1008,91	5,14	9,91	,0988
58	,95090	—	141,82	235,53	6,29	42,46	,4232	8	,98806	—	1028,30	1123,31	4,99	8,90	,0887
57	,95154	—	144,31	237,98	6,33	42,01	,4188	7	,98927	—	1175,20	1270,35	4,85	7,87	,0784
56	,95218	—	146,90	240,53	6,37	41,57	,4144	6	,99051	—	1371,07	1466,36	4,71	6,82	,0680
100 + 55	,95283	—	149,57	243,17	6,40	41,12	,4098	100 + 5	,99182	—	1645,28	1740,73	4,55	5,74	,0572
54	,95346	—	152,30	245,89	6,41	40,67	,4053	4	,99320	—	2056,61	2152,21	4,40	4,65	,0463
53	,95410	—	155,17	248,74	6,43	40,20	,4007	3	,99464	—	2742,15	2837,91	4,24	3,52	,0351
52	,95473	—	158,16	251,72	6,44	39,73	,3960	2	,99615	—	4113,21	4209,13	4,08	2,38	,0237
51	,95538	—	161,28	254,79	6,49	39,24	,3912	1	,99773	—	8226,42	8322,48	3,94	1,20	,0120

TABLE I. HEAT 67°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	III. Decimal multipliers.
Sp. + W.								Sp. + W.							
100 + 0	,82167	100	—	100,00	—	100,00	,9959	100 + 50	,89387	100	41,11	137,88	3,23	72,53	,7223
1	,82399	—	0,82	100,72	0,10	99,29	,9889	51	,89480	—	41,93	138,66	3,27	72,12	,7183
2	,82625	—	1,65	101,44	0,21	98,58	,9819	52	,89568	—	42,76	139,44	3,32	71,71	,7143
3	,82845	—	2,47	102,16	0,31	97,88	,9750	53	,89657	—	43,58	140,21	3,37	71,31	,7103
4	,83059	—	3,29	102,89	0,40	97,20	,9681	54	,89744	—	44,40	140,99	3,41	70,92	,7064
100 + 5	,83268	—	4,11	103,62	0,49	96,51	,9612	100 + 55	,89830	—	45,22	141,77	3,45	70,53	,7025
6	,83471	—	4,94	104,35	0,59	95,84	,9546	56	,89914	—	46,04	142,55	3,49	70,14	,6987
7	,83669	—	5,76	105,08	0,68	95,17	,9479	57	,89997	—	46,86	143,34	3,52	69,76	,6949
8	,83864	—	6,58	105,82	0,76	94,50	,9413	58	,90079	—	47,69	144,12	3,57	69,38	,6911
9	,84054	—	7,40	106,56	0,84	93,85	,9347	59	,90160	—	48,51	144,90	3,61	69,01	,6874
100 + 10	,84237	—	8,22	107,30	0,92	93,20	,9282	100 + 60	,90239	—	49,33	145,68	3,65	68,64	,6836
11	,84417	—	9,04	108,04	1,00	92,56	,9219	61	,90317	—	50,15	146,47	3,68	68,27	,6800
12	,84593	—	9,87	108,79	1,08	91,92	,9155	62	,90394	—	50,98	147,25	3,73	67,91	,6763
13	,84765	—	10,69	109,54	1,15	91,29	,9093	63	,90470	—	51,80	148,04	3,76	67,55	,6727
14	,84932	—	11,50	110,29	1,21	90,67	,9031	64	,90545	—	52,62	148,82	3,80	67,19	,6692
100 + 15	,85096	—	12,33	111,04	1,29	90,06	,8970	100 + 65	,90619	—	53,45	149,61	3,84	66,84	,6657
16	,85259	—	13,16	111,79	1,37	89,45	,8909	66	,90693	—	54,27	150,39	3,88	66,49	,6622
17	,85419	—	13,98	112,55	1,43	88,85	,8849	67	,90765	—	55,09	151,18	3,91	66,14	,6588
18	,85576	—	14,80	113,30	1,50	88,26	,8790	68	,90837	—	55,91	151,96	3,95	65,80	,6554
19	,85730	—	15,62	114,05	1,57	87,67	,8732	69	,90909	—	56,73	152,75	3,98	65,46	,6520
100 + 20	,85880	—	16,44	114,81	1,63	87,10	,8674	100 + 70	,90978	—	57,55	153,53	4,02	65,13	,6487
21	,86028	—	17,26	115,57	1,69	86,53	,8617	71	,91048	—	58,37	154,31	4,06	64,80	,6454
22	,86174	—	18,09	116,32	1,77	85,96	,8562	72	,91116	—	59,20	155,11	4,09	64,47	,6421
23	,86316	—	18,91	117,08	1,83	85,40	,8506	73	,91181	—	60,02	155,90	4,12	64,14	,6389
24	,86455	—	19,73	117,85	1,88	84,85	,8451	74	,91248	—	60,84	156,69	4,15	63,82	,6357
100 + 25	,86592	—	20,56	118,61	1,95	84,30	,8397	100 + 75	,91312	—	61,67	157,47	4,20	63,50	,6325
26	,86727	—	21,38	119,37	2,01	83,77	,8343	76	,91377	—	62,49	158,26	4,23	63,19	,6293
27	,86860	—	22,20	120,14	2,06	83,24	,8290	77	,91440	—	63,31	159,05	4,26	62,87	,6262
28	,86991	—	23,03	120,90	2,13	82,71	,8238	78	,91503	—	64,13	159,83	4,30	62,56	,6231
29	,87119	—	23,85	121,67	2,18	82,19	,8186	79	,91566	—	64,96	160,63	4,33	62,25	,6200
100 + 30	,87245	—	24,67	122,44	2,23	81,68	,8135	100 + 80	,91625	—	65,78	161,42	4,36	61,95	,6170
31	,87369	—	25,49	123,20	2,29	81,17	,8083	81	,91688	—	66,60	162,21	4,39	61,65	,6140
32	,87490	—	26,31	123,97	2,34	80,67	,8033	82	,91747	—	67,42	162,99	4,43	61,35	,6110
33	,87612	—	27,14	124,74	2,40	80,17	,7985	83	,91807	—	68,24	163,78	4,46	61,06	,6080
34	,87729	—	27,96	125,51	2,45	79,68	,7936	84	,91866	—	69,06	164,58	4,48	60,76	,6051
100 + 35	,87845	—	28,78	126,27	2,51	79,19	,7887	100 + 85	,91924	—	69 89	165,37	4,52	60,47	,6023
36	,87959	—	29,59	127,04	2,55	78,71	,7840	86	,91980	—	70,71	166,16	4,55	60,18	,5994
37	,88070	—	30,42	127,82	2,60	78,24	,7792	87	,92035	—	71,53	166,95	4,58	59,90	,5966
38	,88180	—	31,24	128,59	2,65	77,77	,7745	88	,92090	—	72,36	167,74	4,62	59,62	,5938
39	,88289	—	32,07	129,36	2,71	77,31	,7699	89	,92144	—	73,18	168,54	4,64	59,34	,5910
100 + 40	,88395	—	32,89	130,13	2,76	76,84	,7654	100 + 90	,92198	—	74,00	169,33	4,67	59,06	,5982
41	,88502	—	33,71	130,90	2,81	76,39	,7608	91	,92252	—	74,83	170,12	4,71	58,78	,5855
42	,88607	—	34,54	131,67	2,87	75,94	,7564	92	,92304	—	75,65	170,91	4,74	58,51	,5828
43	,88711	—	35,36	132,45	2,91	75,50	,7520	93	,92358	—	76,47	171,70	4,77	58,24	,5801
44	,88813	—	36,18	133,22	2,96	75,06	,7476	94	,92410	—	77,29	172,50	4,79	57,97	,5774
100 + 45	,88912	—	37,00	133,99	3,01	74,63	,7433	100 + 95	,92462	—	78,10	173,29	4,81	57,71	,5747
46	,89012	—	37,82	134,77	3,05	74,20	,7390	96	,92512	—	78,92	174,07	4,85	57,45	,5722
47	,89108	—	38,64	135,55	3,09	73,77	,7348	97	,92562	—	79,74	174,86	4,88	57,19	,5696
48	,89203	—	39,46	136,32	3,14	73,35	,7306	98	,92611	—	80,56	175,65	4,91	56,93	,5670
49	,89297	—	40,29	137,10	3,19	72,94	,7265	99	,92660	—	81,39	176,45	4,94	56,67	,5644

TABLE II. HEAT 67°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,92709	100	82,22	177,25	4,97	56,42	,5619
99	,92758	—	83,05	178,06	4,99	56,16	,5594
98	,92808	—	83,90	178,88	5,02	55,90	,5568
97	,92857	—	84,77	179,72	5,05	55,64	,5542
96	,92906	—	85,64	180,57	5,07	55,38	,5516
100 + 95	,92956	—	86,55	181,44	5,11	55,12	,5489
94	,93004	—	87,47	182,33	5,14	54,84	,5462
93	,93053	—	88,41	183,24	5,17	54,57	,5435
92	,93102	—	89,37	184,18	5,19	54,29	,5407
91	,93152	—	90,35	185,14	5,21	54,01	,5379
100 + 90	,93200	—	91,36	186,10	5,26	53,73	,5351
89	,93253	—	92,38	187,11	5,27	53,44	,5323
88	,93305	—	93,43	188,13	5,30	53,15	,5294
87	,93357	—	94,51	189,18	5,33	52,86	,5265
86	,93410	—	95,61	190,25	5,36	52,56	,5235
100 + 85	,93463	—	96,74	191,34	5,40	52,26	,5205
84	,93517	—	97,89	192,46	5,43	51,96	,5175
83	,93572	—	99,06	193,61	5,45	51,65	,5144
82	,93627	—	100,27	194,79	5,48	51,34	,5113
81	93683	—	101,51	195,99	5,52	51,02	,5082
100 + 80	,93740	—	102,78	197,22	5,56	50,70	,5050
79	,93795	—	104,08	198,49	5,59	50,38	,5018
78	,93851	—	105,41	199,79	5,62	50,05	,4985
77	,93906	—	106,78	201,13	5,65	49,72	,4952
76	,93962	—	108,19	202,51	5,68	49,38	,4918
100 + 75	,94018	—	109,63	203,92	5,71	49,04	,4884
74	,94076	—	111,10	205,37	5,73	48,70	,4850
73	,94134	—	112,62	206,85	5,77	48,34	,4815
72	,94192	—	114,19	208,39	5,80	47,99	,4780
71	,94251	—	115,80	209,97	5,83	47,63	,4744
100 + 70	,94310	—	117,46	211,59	5,87	47,27	,4707
69	,94370	—	119,15	213,25	5,90	46,89	,4670
68	,94430	—	120,90	214,97	5,93	46,51	,4633
67	,94491	—	122,71	216,75	5,96	46,14	,4595
66	,94552	—	124,58	218,57	6,01	45,76	,4557
100 + 65	,94614	—	126,50	220,45	6,05	45,37	,4518
64	,94676	—	128,47	222,39	6,08	44,97	,4478
63	,94738	—	130,50	224,40	6,10	44,56	,4439
62	,94800	—	132,61	226,47	6,14	44,15	,4398
61	,94862	—	134,78	228,61	6,17	43,75	,4357
100 + 60	,94925	—	137,03	230,82	6,21	43,33	,4315
59	,94989	—	139,36	233,11	6,25	42,90	,4273
58	,95053	—	141,75	235,48	6,27	42,46	,4230
57	,95117	—	144,24	237,93	6,31	42,02	,4186
56	,95182	—	146,83	240,48	6,35	41,58	,4142
100 + 55	,95247	—	149,50	243,12	6,38	41,13	,4096
54	,95311	—	152,23	245,84	6,39	40,67	,4051
53	,95375	—	155,09	248,68	6,41	40,21	,4005
52	,95439	—	158,09	251,66	6,43	39,73	,3958
51	,95504	—	161,21	254,73	6,48	39,25	,3910

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95568	100	164,45	257,93	6,52	38,77	,3861
49	,95634	—	167,81	261,25	6,56	38,28	,3812
48	,95699	—	171,30	264,72	6,58	37,77	,3762
47	,95765	—	174,94	268,35	6,59	37,26	,3711
46	,95831	—	178,74	272,13	6,61	36,74	,3660
100 + 45	,95898	—	182,72	276,09	6,63	36,22	,3608
44	,95964	—	186,87	280,21	6,66	35,68	,3555
43	,96031	—	191,22	284,54	6,68	35,14	,3500
42	,96097	—	195,77	289,09	6,68	34,59	,3445
41	,96163	—	200,55	293,85	6,70	34,03	,3390
100 + 40	,96230	—	205,56	298,85	6,71	33,46	,3333
39	,96297	—	210,83	304,11	6,72	32,88	,3275
38	,96364	—	216,38	309,65	6,73	32,29	,3216
37	,96431	—	222,23	315,50	6,73	31,69	,3157
36	,96498	—	228,40	321,67	6,73	31,08	,3096
100 + 35	,96566	—	234,93	328,19	6,74	30,47	,3035
34	,96634	—	241,84	335,11	6,73	29,84	,2972
33	,96702	—	249,16	342,48	6,68	29,20	,2908
32	,96771	—	256,95	350,28	6,67	28,55	,2843
31	,96840	—	265,23	358,58	6,65	27,89	,2777
100 + 30	,96911	—	274,08	367,41	6,67	27,22	,2711
29	,96980	—	283,53	376,87	6,66	26,53	,2643
28	,97050	—	293,66	387,03	6,63	25,84	,2573
27	,97122	—	304,54	397,96	6,58	25,13	,2503
26	,97194	—	316,25	409,69	6,56	24,41	,2431
100 + 25	,97266	—	328,89	422,37	6,52	23,68	,2358
24	,97341	—	342,60	436,12	6,48	22,93	,2284
23	,97416	—	357,50	451,07	6,43	22,17	,2208
22	,97493	—	373,74	467,36	6,38	21,39	,2131
21	,97572	—	391,55	485,22	6,32	20,61	,2052
100 + 20	,97652	—	411,12	504,85	6,27	19,80	,1973
19	,97732	—	432,76	526,57	6,19	18,99	,1892
18	,97814	—	456,80	550,67	6,13	18,16	,1808
17	,97899	—	483,68	577,63	6,05	17,31	,1724
16	,97986	—	513,91	607,94	5,97	16,45	,1638
100 + 15	,98076	—	548,17	642,30	5,87	15,57	,1551
14	,98166	—	587,32	681,57	5,75	14,67	,1462
13	,98261	—	632,50	726,84	5,64	13,76	,1370
12	,98360	—	685,21	779,67	5,54	12,82	,1277
11	,98462	—	747,50	842,08	5,42	11,87	,1183
100 + 10	,98566	—	822,25	916,95	5,30	10,90	,1086
9	,98677	—	913,62	1008,46	5,16	9,91	,0988
8	,98793	—	1027,81	1122,80	5,01	8,91	,0887
7	,98914	—	1174,65	1269,77	4,88	7,88	,0784
6	,99039	—	1370,42	1465,69	4,73	6,82	,0679
100 + 5	,99170	—	1644,51	1739,93	4,58	5,74	,0572
4	,99308	—	2055,63	2151,21	4,42	4,65	,0463
3	,99453	—	2740,85	2836,58	4,27	3,53	,0351
2	,99604	—	4111,27	4207,16	4,11	2,38	,0237
1	,99762	—	8221,55	8318,57	3,98	1,20	,0120

TABLE I. HEAT 68°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82119	100	—	100,00	—	100,00	,9954
1	,82351	—	0,82	100,72	0,10	99,29	,9883
2	,82577	—	1,64	101,44	0,20	98,58	,9813
3	,82797	—	2,47	102,16	0,31	97,88	,9744
4	,83011	—	3,29	102,89	0,40	97,20	,9676
100 + 5	,83221	—	4,11	103,62	0,49	96,51	,9607
6	,83423	—	4,94	104,35	0,59	95,84	,9540
7	,83621	—	5,76	105,08	0,68	95,17	,9474
8	,83816	—	6,58	105,82	0,76	94,50	,9408
9	,84006	—	7,40	106,56	0,84	93,85	,9343
100 + 10	,84189	—	8,22	107,30	0,92	93,20	,9277
11	,84369	—	9,04	108,04	1,00	92,56	,9214
12	,84544	—	9,86	108,79	1,07	91,92	,9150
13	,84716	—	10,68	109,54	1,14	91,29	,9088
14	,84884	—	11,50	110,29	1,21	90,67	,9026
100 + 15	,85048	—	12,33	111,04	1,29	90,06	,8965
16	,85211	—	13,15	111,79	1,36	89,45	,8904
17	,85371	—	13,97	112,55	1,42	88,86	,8844
18	,85528	—	14,79	113,30	1,49	88,26	,8785
19	,85682	—	15,61	114,05	1,56	87,68	,8727
100 + 20	,85832	—	16,43	114,81	1,62	87,10	,8670
21	,85980	—	17,25	115,57	1,68	86,53	,8613
22	,86126	—	18,08	116,32	1,76	85,97	,8557
23	,86269	—	18,90	117,08	1,82	85,41	,8502
24	,86408	—	19,72	117,84	1,88	84,85	,8446
100 + 25	,86545	—	20,55	118,61	1,94	84,31	,8392
26	,86680	—	21,37	119,37	2,00	83,77	,8338
27	,86813	—	22,19	120,13	2,06	83,24	,8285
28	,86944	—	23,02	120,90	2,12	82,71	,8234
29	,87073	—	23,84	121,66	2,18	82,19	,8182
100 + 30	,87198	—	24,66	122,43	2,23	81,68	,8130
31	,87323	—	25,47	123,19	2,28	81,17	,8079
32	,87444	—	26,30	123,96	2,34	80,67	,8029
33	,87565	—	27,12	124,73	2,39	80,17	,7981
34	,87683	—	27,94	125,50	2,44	79,68	,7932
100 + 35	,87799	—	28,77	126,27	2,50	79,19	,7883
36	,87912	—	29,58	127,04	2,54	78,71	,7836
37	,88023	—	30,41	127,81	2,60	78,24	,7788
38	,88133	—	31,23	128,58	2,65	77,77	,7741
39	,88242	—	32,05	129,35	2,70	77,31	,7695
100 + 40	,88348	—	32,87	130,13	2,74	76,85	,7650
41	,88455	—	33,69	130,89	2,80	76,39	,7604
42	,88560	—	34,52	131,67	2,85	75,94	,7560
43	,88664	—	35,34	132,44	2,90	75,50	,7516
44	,88766	—	36,16	133,21	2,95	75,06	,7472
100 + 45	,88866	—	36,99	133,99	3,00	74,63	,7429
46	,88966	—	37,80	134,76	3,04	74,20	,7386
47	,89062	—	38,62	135,54	3,08	73,78	,7344
48	,89157	—	39,44	136,31	3,13	73,36	,7303
49	,89251	—	40,27	137,09	3,18	72,94	,7261

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89342	100	41,09	137,87	3,22	72,53	,7220
51	,89434	—	41,91	138,65	3,26	72,13	,7180
52	,89523	—	42,74	139,43	3,31	71,72	,7140
53	,89612	—	43,56	140,20	3,36	71,32	,7099
54	,89699	—	44,38	140,98	3,40	70,93	,7060
100 + 55	,89785	—	45,20	141,76	3,44	70,54	,7021
56	,89869	—	46,02	142,54	3,48	70,15	,6983
57	,89952	—	46,84	143,33	3,51	69,77	,6945
58	,90034	—	47,66	144,11	3,55	69,39	,6908
59	,90115	—	48,48	144,89	3,59	69,02	,6871
100 + 60	,90194	—	49,31	145,67	3,64	68,65	,6833
61	,90272	—	50,13	146,46	3,67	68,28	,6796
62	,90349	—	50,95	147,24	3,71	67,91	,6760
63	,90425	—	51,77	148,02	3,75	67,55	,6724
64	,90500	—	52,59	148,81	3,78	67,20	,6689
100 + 65	,90574	—	53,42	149,59	3,83	66,85	,6654
66	,90648	—	54,24	150,37	3,87	66,50	,6619
67	,90721	—	55,06	151,16	3,90	66,15	,6585
68	,90793	—	55,88	151,94	3,94	65,81	,6551
69	,90865	—	56,70	152,73	3,97	65,47	,6517
100 + 70	,90934	—	57,53	153,52	4,01	65,14	,6484
71	,91004	—	58,35	154,30	4,05	64,81	,6451
72	,91072	—	59,17	155,09	4,08	64,48	,6418
73	,91138	—	59,99	155,88	4,11	64,15	,6386
74	,91204	—	60,81	156,67	4,14	63,83	,6354
100 + 75	,91268	—	61,64	157,45	4,19	63,51	,6322
76	,91332	—	62,46	158,24	4,22	63,19	,6290
77	,91396	—	63,28	159,03	4,25	62,88	,6259
78	,91459	—	64,10	159,82	4,28	62,57	,6228
79	,91521	—	64,93	160,61	4,32	62,26	,6197
100 + 80	,91581	—	65,75	161,40	4,35	61,96	,6167
81	,91643	—	66,57	162,19	4,38	61,66	,6137
82	,91703	—	67,39	162,97	4,42	61,36	,6107
83	,91763	—	68,21	163,77	4,44	61,06	,6077
84	,91822	—	69,03	164,56	4,47	60,77	,6048
100 + 85	,91881	—	69,85	165,35	4,50	60,48	,6020
86	,91937	—	70,67	166,14	4,53	60,19	,5991
87	,91992	—	71,50	166,93	4,57	59,91	,5963
88	,92047	—	72,32	167,72	4,60	59,62	,5935
89	,92101	—	73,14	168,52	4,62	59,34	,5907
100 + 90	,92155	—	73,96	169,31	4,65	59,06	,5879
91	,92209	—	74,79	170,10	4,69	58,79	,5852
92	,92262	—	75,61	170,89	4,72	58,52	,5825
93	,92315	—	76,43	171,68	4,75	58,25	,5798
94	,92367	—	77,25	172,48	4,77	57,98	,5772
100 + 95	,92419	—	78,07	173,27	4,80	57,71	,5745
96	,92469	—	78,88	174,05	4,83	57,45	,5719
97	,92519	—	79,70	174,84	4,86	57,19	,5693
98	,92568	—	80,52	175,63	4,89	56,93	,5667
99	,92617	—	81,35	176,43	4,92	56,67	,5642

TABLE II. HEAT 68°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,92666	100	82,18	177,23	4,95	56,42	,5616	100 + 50	,95535	100	164,37	257,87	6,50	38,78	,3860
99	,92715	—	83,01	178,04	4,97	56,17	,5591	49	,95601	—	167,73	261,19	6,54	38,29	,3811
98	,92765	—	83,86	178,86	5,00	55,91	,5566	48	,95667	—	171,22	264,66	6,56	37,78	,3761
97	,92814	—	84,73	179,69	5,04	55,64	,5539	47	,95733	—	174,86	268,28	6,58	37,27	,3710
96	,92864	—	85,60	180,54	5,06	55,38	,5513	46	,95799	—	178,66	272,06	6,60	36,75	,3659
100 + 95	,92913	—	86,51	181,41	5,10	55,12	,5487	100 + 45	,95866	—	182,64	276,02	6,62	36,23	,3606
94	,92962	—	87,43	182,30	5,13	54,85	,5460	44	,95933	—	186,78	280,14	6,64	35,69	,3553
93	,93011	—	88,37	183,22	5,15	54,58	,5433	43	,96000	—	191,13	284,47	6,66	35,15	,3499
92	,93060	—	89,33	184,15	5,18	54,30	,5405	42	,96067	—	195,68	289,01	6,67	34,60	,3444
91	,93110	—	90,31	185,11	5,20	54,02	,5377	41	,96133	—	200,46	293,77	6,69	34,04	,3389
100 + 90	,93158	—	91,31	186,08	5,23	53,74	,5349	100 + 40	,96201	—	205,46	298,77	6,69	33,47	,3332
89	,93211	—	92,33	187,09	5,24	53,45	,5321	39	,96268	—	210,73	304,03	6,70	32,89	,3274
88	,93263	—	93,39	188,11	5,28	53,16	,5292	38	,96336	—	216,28	309,56	6,72	32,30	,3216
87	,93315	—	94,46	189,15	5,31	52,87	,5263	37	,96403	—	222,12	315,41	6,71	31,70	,3156
86	,93368	—	95,56	190,22	5,34	52,57	,5233	36	,96470	—	228,29	321,58	6,71	31,09	,3095
100 + 85	,93421	—	96,69	191,31	5,38	52,27	,5203	100 + 35	,96539	—	234,82	328,09	6,73	30,48	,3034
84	,93475	—	97,84	192,43	5,41	51,97	,5173	34	,96607	—	241,72	335,01	6,71	29,85	,2971
83	,93530	—	99,01	193,58	5,43	51,66	,5142	33	,96676	—	249,04	342,37	6,67	29,21	,2908
82	,93586	—	100,22	194,76	5,46	51,34	,5111	32	,96745	—	256,83	350,17	6,66	28,56	,2843
81	,93642	—	101,46	195,96	5,50	51,03	,5080	31	,96815	—	265,11	358,46	6,65	27,90	,2777
100 + 80	,93698	—	102,73	197,19	5,54	50,71	,5048	100 + 30	,96886	—	273,95	367,29	6,66	27,23	,2710
79	,93754	—	104,03	198,46	5,57	50,39	,5016	29	,96956	—	283,40	376,75	6,65	26,54	,2642
78	,93810	—	105,36	199,76	5,60	50,06	,4983	28	,97027	—	293,52	386,91	6,61	25,85	,2573
77	,93865	—	106,73	201,10	5,63	49,72	,4950	27	,97099	—	304,39	397,83	6,56	25,14	,2502
76	,93922	—	108,14	202,48	5,66	49,38	,4916	26	,97172	—	316,10	409,56	6,54	24,42	,2430
100 + 75	,93978	—	109,58	203,89	5,69	49,04	,4882	100 + 25	,97245	—	328,74	422,22	6,52	23,69	,2357
74	,94036	—	111,05	205,34	5,71	48,70	,4848	24	,97320	—	342,44	435,96	6,48	22,94	,2283
73	,94094	—	112,57	206,82	5,75	48,35	,4813	23	,97396	—	357,33	450,90	6,43	22,18	,2208
72	,94153	—	114,14	208,36	5,78	47,99	,4778	22	,97474	—	373,57	467,18	6,39	21,40	,2131
71	,94212	—	115,75	209,94	5,81	47,64	,4742	21	,97553	—	391,36	485,03	6,33	20,61	,2052
100 + 70	,94271	—	117,40	211,55	5,85	47,27	,4705	100 + 20	,97634	—	410,93	504,65	6,28	19,81	,1972
69	,94331	—	119,10	213,21	5,89	46,90	,4668	19	,97714	—	432,56	526,36	6,20	19,00	,1891
68	,94392	—	120,84	214,93	5,91	46,52	,4631	18	,97797	—	456,59	550,45	6,14	18,17	,1808
67	,94453	—	122,65	216,71	5,94	46,15	,4593	17	,97882	—	483,45	577,39	6,06	17,32	,1724
66	,94514	—	124,52	218,53	5,99	45,76	,4555	16	,97970	—	513,67	607,69	5,98	16,46	,1638
100 + 65	,94576	—	126,44	220,41	6,03	45,37	,4516	100 + 15	,98060	—	547,91	642,03	5,88	15,58	,1550
64	,94638	—	128,41	222,35	6,06	44,97	,4477	14	,98151	—	587,04	681,28	5,76	14,68	,1461
63	,94700	—	130,44	224,35	6,09	44,57	,4437	13	,98246	—	632,20	726,53	5,67	13,76	,1370
62	,94762	—	132,54	226,43	6,11	44,16	,4396	12	,98346	—	684,89	779,33	5,56	12,83	,1277
61	,94825	—	134,72	228,56	6,16	43,75	,4355	11	,98448	—	747,15	841,71	5,44	11,88	,1183
100 + 60	,94888	—	136,97	230,77	6,20	43,34	,4313	100 + 10	,98553	—	821,86	916,54	5,32	10,91	,1086
59	,94952	—	139,29	233,07	6,22	42,91	,4271	9	,98664	—	913,19	1008,01	5,18	9,92	,0987
58	,95016	—	141,68	235,44	6,24	42,47	,4228	8	,98780	—	1027,33	1122,29	5,04	8,91	,0887
57	,95080	—	144,17	237,88	6,29	42,03	,4184	7	,98901	—	1174,10	1269,19	4,91	7,88	,0784
56	,95146	—	146,76	240,43	6,33	41,59	,4140	6	,99027	—	1369,78	1465,02	4,76	6,83	,0679
100 + 55	,95211	—	149,43	243,07	6,36	41,14	,4095	100 + 5	,99158	—	1643,74	1739,13	4,61	5,75	,0572
54	,95276	—	152,16	245,79	6,37	40,68	,4049	4	,99296	—	2054,67	2150,23	4,44	4,65	,0463
53	,95340	—	155,02	248,63	6,39	40,21	,4003	3	,99441	—	2739,56	2835,26	4,30	3,53	,0351
52	,95405	—	158,01	251,60	6,41	39,74	,3956	2	,99593	—	4109,34	4205,19	4,15	2,38	,0237
51	,95470	—	161,13	254,67	6,46	39,26	,3908	1	,99751	—	8218,68	8314,68	4,00	1,20	,0120

TABLE I. HEAT 69°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,82071	100	—	100,00	—	100,00	,9948
1	,82303	—	0,82	100,72	0,10	99,29	,9877
2	,82529	—	1,64	101,44	0,20	98,58	,9807
3	,82749	—	2,46	102,16	0,30	97,89	,9738
4	,82963	—	3,28	102,88	0,40	97,20	,9670
100 + 5	,83173	—	4,11	103,62	0,49	96,51	,9601
6	,83375	—	4,93	104,34	0,59	95,84	,9534
7	,83573	—	5,75	105,08	0,67	95,17	,9468
8	,83768	—	6,58	105,82	0,76	94,51	,9402
9	,83957	—	7,40	106,55	0,85	93,85	,9337
100 + 10	,84141	—	8,22	107,29	0,93	93,20	,9272
11	,84320	—	9,03	108,04	0,99	92,56	,9208
12	,84495	—	9,86	108,79	1,07	91,93	,9145
13	,84666	—	10,68	109,54	1,14	91,30	,9083
14	,84835	—	11,49	110,28	1,21	90,68	,9021
100 + 15	,84999	—	12,32	111,04	1,28	90,06	,8960
16	,85163	—	13,15	111,79	1,36	89,46	,8899
17	,85323	—	13,96	112,54	1,42	88,86	,8839
18	,85480	—	14,78	113,29	1,49	88,27	,8780
19	,85634	—	15,61	114,05	1,56	87,68	,8722
100 + 20	,85784	—	16,42	114,81	1,61	87,10	,8665
21	,85932	—	17,24	115,56	1,68	86,53	,8608
22	,86078	—	18,07	116,31	1,76	85,97	,8552
23	,86221	—	18,89	117,07	1,82	85,41	,8497
24	,86361	—	19,71	117,84	1,87	84,86	,8442
100 + 25	,86498	—	20,54	118,60	1,94	84,31	,8388
26	,86633	—	21,36	119,36	2,00	83,78	,8334
27	,86766	—	22,18	120,13	2,05	83,25	,8281
28	,86897	—	23,00	120,89	2,11	82,72	,8229
29	,87026	—	23,83	121,66	2,17	82,20	,8177
100 + 30	,87151	—	24,64	122,42	2,22	81,69	,8126
31	,87276	—	25,46	123,19	2,27	81,18	,8075
32	,87398	—	26,28	123,96	2,32	80,68	,8025
33	,87518	—	27,11	124,73	2,38	80,18	,7976
34	,87636	—	27,93	125,50	2,43	79,68	,7927
100 + 35	,87752	—	28,75	126,26	2,49	79,19	,7879
36	,87865	—	29,57	127,03	2,54	78,71	,7832
37	,87976	—	30,39	127,80	2,59	78,24	,7784
38	,88086	—	31,21	128,58	2,63	77,77	,7737
39	,88195	—	32,04	129,35	2,69	77,31	,7691
100 + 40	,88301	—	32,86	130,12	2,74	76,85	,7646
41	,88408	—	33,68	130,89	2,79	76,39	,7600
42	,88513	—	34,51	131,66	2,85	75,95	,7556
43	,88617	—	35,33	132,43	2,90	75,51	,7512
44	,88719	—	36,15	133,21	2,94	75,07	,7468
100 + 45	,88818	—	36,97	133,98	2,99	74,64	,7425
46	,88919	—	37,78	134,76	3,02	74,21	,7382
47	,89016	—	38,60	135,53	3,07	73,78	,7340
48	,89111	—	39,42	136,30	3,12	73,36	,7299
49	,89205	—	40,25	137,08	3,17	72,95	,7257

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89297	100	41,07	137,86	3,21	72,54	,7216
51	,89389	—	41,89	138,64	3,25	72,13	,7176
52	,89478	—	42,72	139,42	3,30	71,72	,7136
53	,89567	—	43,54	140,19	3,35	71,32	,7096
54	,89654	—	44,36	140,97	3,39	70,93	,7057
100 + 55	,89740	—	45,18	141,75	3,43	70,54	,7018
56	,89824	—	46,00	142,53	3,47	70,15	,6980
57	,89907	—	46,82	143,32	3,50	69,77	,6942
58	,89989	—	47,64	144,10	3,54	69,39	,6904
59	,90070	—	48,46	144,88	3,58	69,02	,6867
100 + 60	,90149	—	49,29	145,66	3,63	68,66	,6829
61	,90227	—	50,11	146,45	3,66	68,29	,6793
62	,90304	—	50,93	147,23	3,70	67,92	,6756
63	,90380	—	51,75	148,01	3,74	67,56	,6720
64	,90455	—	52,57	148,80	3,77	67,20	,6685
100 + 65	,90529	—	53,39	149,58	3,81	66,85	,6650
66	,90603	—	54,21	150,36	3,85	66,50	,6616
67	,90677	—	55,03	151,15	3,88	66,15	,6582
68	,90749	—	55,85	151,93	3,92	65,81	,6548
69	,90821	—	56,67	152,71	3,96	65,48	,6514
100 + 70	,90890	—	57,50	153,51	3,99	65,14	,6481
71	,90960	—	58,32	154,28	4,04	64,81	,6448
72	,91028	—	59,14	155,07	4,07	64,48	,6415
73	,91094	—	59,96	155,86	4,10	64,15	,6383
74	,91160	—	60,78	156,66	4,12	63,83	,6351
100 + 75	,91224	—	61,61	157,44	4,17	63,51	,6319
76	,91288	—	62,43	158,23	4,20	63,20	,6287
77	,91352	—	63,25	159,01	4,24	62,88	,6256
78	,91415	—	64,07	159,80	4,27	62,57	,6225
79	,91477	—	64,90	160,59	4,31	62,26	,6194
100 + 80	,91537	—	65,72	161,38	4,34	61,96	,6164
81	,91599	—	66,54	162,17	4,37	61,66	,6134
82	,91659	—	67,36	162,95	4,41	61,36	,6104
83	,91719	—	68,18	163,75	4,43	61,07	,6074
84	,91778	—	69,00	164,54	4,46	60,77	,6045
100 + 85	,91837	—	69,82	165,33	4,49	60,48	,6017
86	,91894	—	70,64	166,12	4,52	60,20	,5988
87	,91949	—	71,46	166,91	4,55	59,91	,5960
88	,92004	—	72,29	167,70	4,59	59,63	,5932
89	,92058	—	73,11	168,50	4,61	59,35	,5904
100 + 90	,92112	—	73,93	169,29	4,64	59,07	,5876
91	,92166	—	74,75	170,08	4,67	58,79	,5849
92	,92219	—	75,57	170,87	4,70	58,52	,5822
93	,92272	—	76,39	171,66	4,73	58,25	,5795
94	,92324	—	77,22	172,46	4,76	57,98	,5769
100 + 95	,92376	—	78,03	173,25	4,78	57,72	,5742
96	,92426	—	78,84	174,03	4,81	57,46	,5716
97	,92476	—	79,66	174,82	4,84	57,20	,5691
98	,92525	—	80,48	175,61	4,87	56,94	,5665
99	,92574	—	81,31	176,41	4,90	56,68	,5639

TABLE II. HEAT 69°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,92623	100	82,14	177,21	4,93	56,43	,5613
99	,92672	—	82,97	178,02	4,95	56,17	,5588
98	,92722	—	83,82	178,84	4,98	55,91	,5563
97	,92772	—	84,69	179,67	5,02	55,65	,5537
96	,92822	—	85,57	180,52	5,05	55,39	,5511
100 + 95	,92870	—	86,47	181,39	5,08	55,13	,5484
94	,92920	—	87,39	182,28	5,11	54,86	,5457
93	,92969	—	88,33	183,20	5,13	54,58	,5430
92	,93018	—	89,29	184,13	5,16	54,31	,5402
91	,93068	—	90,27	185,08	5,19	54,03	,5374
100 + 90	,93116	—	91,27	186,06	5,21	53,74	,5346
89	,93169	—	92,29	187,06	5,23	53,46	,5318
88	,93221	—	93,34	188,09	5,25	53,17	,5290
87	,93273	—	94,42	189,12	5,30	52,87	,5260
86	,93326	—	95,51	190,19	5,32	52,58	,5230
100 + 85	,93379	—	96,64	191,28	5,36	52,28	,5200
84	,93434	—	97,79	192,40	5,39	51,98	,5170
83	,93489	—	98,96	193,55	5,41	51,67	,5140
82	,93545	—	100,17	194,73	5,44	51,35	,5109
81	,93601	—	101,41	195,93	5,48	51,04	,5078
100 + 80	,93657	—	102,68	197,16	5,52	50,72	,5046
79	,93713	—	103,98	198,43	5,55	50,39	,5013
78	,93769	—	105,31	199,73	5,58	50,06	,4981
77	,93825	—	106,68	201,07	5,61	49,73	,4948
76	,93882	—	108,09	202,45	5,64	49,39	,4914
100 + 75	,93938	—	109,53	203,86	5,67	49,05	,4880
74	,93996	—	111,00	205,31	5,69	48,71	,4846
73	,94055	—	112,52	206,79	5,73	48,36	,4811
72	,94114	—	114,09	208,32	5,77	48,00	,4776
71	,94173	—	115,70	209,90	5,80	47,64	,4740
100 + 70	,94232	—	117,35	211,51	5,84	47,28	,4703
69	,94293	—	119,04	213,17	5,87	46,91	,4666
68	,94354	—	120,79	214,90	5,89	46,53	,4629
67	,94415	—	122,60	216,67	5,93	46,16	,4591
66	,94476	—	124,46	218,49	5,97	45,77	,4553
100 + 65	,94538	—	126,38	220,37	6,01	45,38	,4514
64	,94600	—	128,35	222,31	6,04	44,98	,4475
63	,94662	—	130,38	224,31	6,07	44,58	,4435
62	,94725	—	132,48	226,38	6,10	44,17	,4394
61	,94788	—	134,66	228,52	6,14	43,76	,4353
100 + 60	,94851	—	136,91	230,74	6,17	43,34	,4311
59	,94915	—	139,22	233,02	6,20	42,91	,4269
58	,94979	—	141,62	235,39	6,23	42,48	,4226
57	,95043	—	144,11	237,84	6,27	42,04	,4183
56	,95110	—	146,69	240,38	6,31	41,60	,4138
100 + 55	,95175	—	149,36	243,02	6,34	41,15	,4093
54	,95241	—	152,09	245,74	6,35	40,69	,4048
53	,95305	—	154,95	248,58	6,37	40,22	,4002
52	,95371	—	157,94	251,54	6,40	39,75	,3955
51	,95437	—	161,05	254,61	6,44	39,27	,3907

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95502	100	164,29	257,81	6,48	38,79	,3859
49	,95568	—	167,65	261,13	6,52	38,30	,3810
48	,95634	—	171,14	264,60	6,54	37,79	,3760
47	,95701	—	174,78	268,21	6,57	37,28	,3709
46	,95767	—	178,58	271,99	6,59	36,76	,3658
100 + 45	,95834	—	182,56	275,95	6,61	36,24	,3605
44	,95902	—	186,69	280,07	6,62	35,70	,3552
43	,95969	—	191,04	284,40	6,64	35,16	,3498
42	,96037	—	195,59	288,94	6,65	34,61	,3443
41	,96104	—	200,36	293,69	6,67	34,05	,3387
100 + 40	,96172	—	205,36	298,69	6,67	33,48	,3330
39	,96240	—	210,63	303,94	6,69	32,90	,3273
38	,96308	—	216,18	309,48	6,70	32,31	,3215
37	,96375	—	222,02	315,32	6,70	31,71	,3155
36	,96443	—	228,18	321,49	6,69	31,10	,3094
100 + 35	,96511	—	234,71	327,99	6,72	30,49	,3033
34	,96580	—	241,61	334,91	6,70	29,86	,2970
33	,96650	—	248,93	342,26	6,67	29,22	,2907
32	,96720	—	256,71	350,05	6,66	28,57	,2842
31	,96790	—	264,99	358,35	6,64	27,91	,2776
100 + 30	,96861	—	273,82	367,17	6,65	27,24	,2709
29	,96932	—	283,27	376,63	6,64	26,55	,2641
28	,97004	—	293,38	386,79	6,59	25,86	,2572
27	,97077	—	304,25	397,70	6,55	25,15	,2502
26	,97150	—	315,95	409,43	6,52	24,43	,2430
100 + 25	,97224	—	328,59	422,07	6,52	23,70	,2357
24	,97300	—	342,28	435,80	6,48	22,95	,2283
23	,97376	—	357,16	450,73	6,43	22,19	,2207
22	,97455	—	373,40	467,00	6,40	21,41	,2130
21	,97534	—	391,18	484,84	6,34	20,62	,2052
100 + 20	,97615	—	410,74	504,45	6,29	19,82	,1972
19	,97696	—	432,36	526,15	6,21	19,01	,1890
18	,97780	—	456,38	550,23	6,15	18,17	,1807
17	,97865	—	483,22	577,15	6,07	17,33	,1723
16	,97954	—	513,43	607,44	5,99	16,46	,1637
100 + 15	,98044	—	547,65	641,76	5,89	15,58	,1550
14	,98136	—	586,77	680,99	5,78	14,68	,1461
13	,98232	—	631,90	726,22	5,68	13,77	,1370
12	,98332	—	684,57	778,99	5,58	12,84	,1277
11	,98434	—	746,80	841,34	5,46	11,88	,1182
100 + 10	,98540	—	821,48	916,13	5,35	10,91	,1086
9	,98651	—	912,76	1007,56	5,20	9,92	,0987
8	,98767	—	1026,85	1121,78	5,07	8,91	,0887
7	,98889	—	1173,55	1268,61	4,94	7,88	,0784
6	,99015	—	1369,14	1464,35	4,79	6,83	,0679
100 + 5	,99146	—	1642,97	1738,33	4,64	5,75	,0572
4	,99284	—	2053,70	2149,23	4,47	4,65	,0463
3	,99429	—	2738,28	2833,95	4,33	3,53	,0351
2	,99581	—	4107,42	4203,24	4,18	2,38	,0237
1	,99740	—	8214,83	8310,80	4,03	1,20	,0120

TABLE I. HEAT 70°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.								Sp. + W.							
100 + 0	,82023	100	—	100,00	—	100,00	,9942	100 + 50	,89252	100	41,05	137,85	3,20	72,54	,7212
1	,82255	—	0,82	100,72	0,10	99,29	,9871	51	,89343	—	41,88	138,63	3,25	72,14	,7172
2	,82481	—	1,64	101,44	0,20	98,58	,9801	52	,89433	—	42,70	139,41	3,29	71,73	,7132
3	,82701	—	2,46	102,16	0,30	97,89	,9732	53	,89522	—	43,52	140,18	3,34	71,33	,7092
4	,82915	—	3,28	102,88	0,40	97,20	,9664	54	,89609	—	44,34	140,96	3,38	70,94	,7053
100 + 5	,83124	—	4,10	103,61	0,49	96,52	,9596	100 + 55	,89695	—	45,16	141,74	3,42	70,55	,7014
6	,83327	—	4,93	104,34	0,59	95,84	,9529	56	,89779	—	45,98	142,52	3,46	70,16	,6976
7	,83525	—	5,75	105,08	0,67	95,17	,9462	57	,89862	—	46,80	143,31	3,49	69,78	,6938
8	,83719	—	6,57	105,81	0,76	94,51	,9396	58	,89944	—	47,62	144,09	3,53	69,40	,6900
9	,83908	—	7,39	106,55	0,84	93,85	,9331	59	,90025	—	48,44	144,87	3,57	69,03	,6863
100 + 10	,84092	—	8,21	107,29	0,92	93,20	,9266	100 + 60	,90104	—	49,27	145,65	3,62	68,66	,6826
11	,84271	—	9,03	108,04	0,99	92,56	,9202	61	,90182	—	50,09	146,44	3,65	68,29	,6789
12	,84446	—	9,85	108,78	1,07	91,93	,9139	62	,90259	—	50,91	147,22	3,69	67,92	,6753
13	,84618	—	10,67	109,54	1,13	91,30	,9077	63	,90335	—	51,73	148,00	3,73	67,56	,6717
14	,84786	—	11,49	110,28	1,21	90,68	,9015	64	,90410	—	52,55	148,79	3,76	67,21	,6682
100 + 15	,84951	—	12,32	111,04	1,28	90,06	,8954	100 + 65	,90484	—	53,37	149,57	3,80	66,86	,6647
16	,85114	—	13,14	111,79	1,35	89,46	,8894	66	,90558	—	54,19	150,35	3,84	66,51	,6612
17	,85274	—	13,96	112,54	1,42	88,86	,8834	67	,90632	—	55,01	151,14	3,87	66,16	,6578
18	,85431	—	14,78	113,29	1,49	88,27	,8775	68	,90705	—	55,83	151,92	3,91	65,82	,6544
19	,85585	—	15,60	114,04	1,56	87,68	,8717	69	,90777	—	56,65	152,70	3,95	65,49	,6510
100 + 20	,85736	—	16,42	114,80	1,62	87,11	,8660	100 + 70	,90847	—	57,48	153,49	3,99	65,15	,6477
21	,85884	—	17,24	115,56	1,68	86,54	,8603	71	,90916	—	58,30	154,27	4,03	64,82	,6444
22	,86030	—	18,06	116,31	1,75	85,97	,8547	72	,90984	—	59,12	155,06	4,06	64,49	,6411
23	,86173	—	18,88	117,07	1,81	85,41	,8492	73	,91050	—	59,94	155,85	4,09	64,16	,6379
24	,86313	—	19,71	117,83	1,88	84,86	,8437	74	,91116	—	60,76	156,64	4,12	63,84	,6347
100 + 25	,86451	—	20,53	118,60	1,93	84,32	,8383	100 + 75	,91181	—	61,58	157,42	4,16	63,52	,6316
26	,86586	—	21,35	119,36	1,99	83,78	,8330	76	,91245	—	62,40	158,21	4,19	63,21	,6284
27	,86719	—	22,17	120,12	2,05	83,25	,8277	77	,91308	—	63,22	159,00	4,22	62,89	,6253
28	,86850	—	22,99	120,89	2,10	82,72	,8225	78	,91370	—	64,04	159,79	4,25	62,58	,6222
29	,86979	—	23,81	121,65	2,16	82,20	,8173	79	,91432	—	64,87	160,58	4,29	62,27	,6191
100 + 30	,87105	—	24,63	122,41	2,22	81,69	,8122	100 + 80	,91493	—	65,69	161,37	4,32	61,97	,6161
31	,87229	—	25,45	123,18	2,27	81,18	,8071	81	,91554	—	66,51	162,16	4,35	61,67	,6131
32	,87351	—	26,27	123,95	2,32	80,68	,8021	82	,91615	—	67,33	162,94	4,39	61,37	,6101
33	,87471	—	27,10	124,72	2,38	80,18	,7972	83	,91675	—	68,15	163,73	4,42	61,08	,6072
34	,87589	—	27,92	125,49	2,43	79,69	,7923	84	,91734	—	68,97	164,52	4,45	60,78	,6043
100 + 35	,87705	—	28,74	126,25	2,49	79,20	,7875	100 + 85	,91793	—	69,79	165,31	4,48	60,49	,6014
36	,87818	—	29,56	127,02	2,54	78,72	,7827	86	,91850	—	70,61	166,10	4,51	60,20	,5985
37	,87929	—	30,38	127,80	2,58	78,25	,7780	87	,91906	—	71,43	166,89	4,54	59,92	,5957
38	,88039	—	31,20	128,57	2,63	77,78	,7733	88	,91961	—	72,26	167,68	4,58	59,64	,5929
39	,88147	—	32,02	129,34	2,68	77,32	,7687	89	,92015	—	73,08	168,48	4,60	59,36	,5901
100 + 40	,88254	—	32,84	130,11	2,73	76,86	,7641	100 + 90	,92069	—	73,90	169,27	4,63	59,08	,5874
41	,88361	—	33,66	130,88	2,78	76,40	,7596	91	,92123	—	74,72	170,06	4,66	58,80	,5846
42	,88466	—	34,49	131,65	2,84	75,95	,7551	92	,92176	—	75,54	170,85	4,69	58,53	,5819
43	,88570	—	35,31	132,43	2,88	75,51	,7507	93	,92229	—	76,36	171,64	4,72	58,26	,5792
44	,88672	—	36,13	133,20	2,93	75,07	,7464	94	,92281	—	77,18	172,44	4,74	57,99	,5766
100 + 45	,88773	—	36,95	133,97	2,98	74,64	,7421	100 + 95	,92333	—	78,00	173,23	4,77	57,73	,5739
46	,88872	—	37,77	134,75	3,02	74,21	,7378	96	,92383	—	78,81	174,01	4,80	57,47	,5713
47	,88969	—	38,59	135,52	3,07	73,79	,7336	97	,92433	—	79,63	174,80	4,83	57,21	,5688
48	,89065	—	39,41	136,30	3,11	73,37	,7295	98	,92482	—	80,45	175,59	4,86	56,95	,5662
49	,89159	—	40,23	137,07	3,16	72,95	,7253	99	,92531	—	81,28	176,39	4,89	56,69	,5636

TABLE II. HEAT 70°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,92580	100	82,11	177,19	4,92	56,44	,5611	100 + 50	,95469	100	164,22	257,75	6,47	38,80	,3857
99	,92629	—	82,94	178,00	4,94	56,18	,5585	49	,95535	—	167,57	261,07	6,50	38,30	,3808
98	,92679	—	83,79	178,82	4,97	55,92	,5560	48	,95601	—	171,06	264,53	6,53	37,80	,3758
97	,92729	—	84,66	179,65	5,01	55,66	,5534	47	,95668	—	174,70	268,15	6,55	37,29	,3707
96	,92779	—	85,54	180,50	5,04	55,40	,5508	46	,95735	—	178,50	271,93	6,57	36,77	,3656
100 + 95	,92828	—	86,43	181,37	5,06	55,14	,5482	100 + 45	,95802	—	182,47	275,88	6,59	36,25	,3604
94	,92877	—	87,35	182,26	5,09	54,86	,5455	44	,95870	—	186,61	280,00	6,61	35,71	,3551
93	,92926	—	88,29	183,18	5,11	54,59	,5428	43	,95938	—	190,95	284,33	6,62	35,17	,3497
92	,92976	—	89,25	184,11	5,14	54,31	,5400	42	,96006	—	195,50	288,87	6,63	34,62	,3442
91	,93026	—	90,23	185,06	5,17	54,03	,5372	41	,96074	—	200,27	293,62	6,65	34,06	,3386
100 + 90	,93076	—	91,23	186,04	5,19	53,75	,5344	100 + 40	,96143	—	205,27	298,60	6,67	33,49	,3330
89	,93127	—	92,25	187,04	5,21	53,46	,5316	39	,96211	—	210,54	303,86	6,68	32,91	,3272
88	,93179	—	93,30	188,06	5,24	53,17	,5287	38	,96279	—	216,08	309,40	6,68	32,32	,3214
87	,93231	—	94,37	189,10	5,27	52,88	,5258	37	,96347	—	221,92	315,24	6,68	31,72	,3154
86	,93284	—	95,47	190,17	5,30	52,58	,5228	36	,96415	—	228,08	321,41	6,67	31,11	,3094
100 + 85	,93337	—	96,60	191,26	5,30	52,28	,5198	100 + 35	,96484	—	234,60	327,90	6,70	30,50	,3032
84	,93392	—	97,75	192,37	5,38	51,98	,5168	34	,96553	—	241,50	334,81	6,69	29,87	,2969
83	,93447	—	98,92	193,52	5,40	51,67	,5137	33	,96623	—	248,82	342,15	6,67	29,23	,2906
82	,93503	—	100,13	194,70	5,43	51,36	,5106	32	,96694	—	256,59	349,94	6,65	28,58	,2841
81	,93559	—	101,37	195,90	5,47	51,04	,5075	31	,96765	—	264,87	358,23	6,64	27,91	,2775
100 + 80	,93616	—	102,64	197,13	5,51	50,73	,5043	100 + 30	,96836	—	273,70	367,05	6,65	27,24	,2709
79	,93672	—	103,94	198,40	5,54	50,40	,5011	29	,96908	—	283,14	376,51	6,63	26,56	,2641
78	,93728	—	105,27	199,70	5,57	50,07	,4978	28	,96980	—	293,25	386,67	6,58	25,86	,2571
77	,93784	—	106,64	201,04	5,60	49,74	,4945	27	,97054	—	304,11	397,57	6,54	25,15	,2501
76	,93841	—	108,04	202.42	5,62	49,40	,4912	26	,97128	—	315,81	409,30	6,51	24,43	,2429
100 + 75	,93898	—	109,48	203,83	5,65	49,06	,4878	100 + 25	,97203	—	328,44	421,92	6,52	23,70	,2356
74	,93956	—	110,95	205,28	5,67	48,72	,4844	24	,97279	—	342,12	435,64	6,48	22,95	,2282
73	,94015	—	112,47	206,76	5,71	48,37	,4809	23	,97356	—	357,00	450,56	6,44	22,19	,2207
72	,94074	—	114,04	208,29	5,75	48,01	,4774	22	,97435	—	373,23	466,83	6,40	21,42	,2130
71	,94133	—	115,65	209,86	5,79	47,65	,4738	21	,97515	—	390,00	484,65	6,35	20,63	,2051
100 + 70	,94193	—	117,30	211,48	5,82	47,29	,4701	100 + 20	,97596	—	410,55	504,26	6,29	19,83	,1971
69	,94254	—	118,99	213,14	5,85	46,92	,4664	19	,97678	—	432,16	525,93	6,23	19,01	,1890
68	,94315	—	120,74	214,86	5,88	46,54	,4627	18	,97762	—	456,17	550,01	6,16	18,18	,1807
67	,94376	—	122,55	216,63	5,92	46,16	,4589	17	,97848	—	483,00	576,92	6,08	17,33	,1723
66	,94438	—	124,40	218,45	5,95	45,78	,4551	16	,97937	—	513,19	607,19	6,00	16,47	,1637
100 + 65	,94500	—	126,32	220,33	5,99	45,39	,4512	100 + 15	,98028	—	547,40	641,49	5,91	15,59	,1550
64	,94562	—	128,29	222,27	6,02	44,99	,4473	14	,98121	—	586,50	680,70	5,80	14,69	,1461
63	,94624	—	130,32	224,27	6,05	44,59	,4433	13	,98217	—	631,61	725,91	5,70	13,77	,1370
62	,94687	—	132,42	226,34	6,08	44,18	,4393	12	,98317	—	684,25	778,65	5,60	12,84	,1277
61	,94750	—	134,60	228,48	6,12	43,77	,4352	11	,98420	—	746,45	840,97	5,48	11,89	,1182
100 + 60	,94813	—	136,85	230,69	6,16	43,35	,4310	100 + 10	,98527	—	821,10	915,72	5,38	10,92	,1086
59	,94877	—	139,16	232,97	6,19	42,92	,4268	9	,98638	—	912,33	1007,11	5,22	9,93	,0987
58	,94942	—	141,56	235,34	6,22	42,49	,4225	8	,98754	—	1026,37	1121,28	5,09	8,92	,0887
57	,95007	—	144,05	237,80	6,25	42,05	,4181	7	,98876	—	1173,00	1268,04	4,96	7,89	,0784
56	,95073	—	146,63	240,34	6,29	41,61	,4137	6	,99002	—	1368,50	1463,68	4,82	6,83	,0679
100 + 55	,95139	—	149,29	242,97	6,32	41,16	,4092	100 + 5	,99134	—	1642,20	1737,53	4,67	5,75	,0572
54	,95205	—	152,02	245,69	6,33	40,70	,4046	4	,99272	—	2052,74	2148,24	4,50	4,65	,0463
53	,95270	—	154,88	248,53	6,35	40,23	,4000	3	,99417	—	2737,00	2832,64	4,36	3,53	,0351
52	,95336	—	157,87	251,48	6,39	39,76	,3953	2	,99569	—	4105,50	4201,29	4,21	2,38	,0237
51	,95403	—	160,98	254,56	6,42	39,28	,3905	1	,99728	—	8210,99	8306,93	4,06	1,20	,0120

TABLE I. HEAT 71°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.	I. Spirit and Water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of Spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							..	Sp. + W.							
100 + 0	,81975	100	—	100,00	—	100,00	,9936	100 + 50	,89206	100	41,03	137,84	3,19	72,55	,7208
1	,82206	—	0,82	100,72	0,10	99,29	,9866	51	,89297	—	41,86	138,62	3,24	72,14	,7169
2	,82432	—	1,64	101,44	0,20	98,58	,9796	52	,89387	—	42,68	139,40	3,28	71,74	,7129
3	,82652	—	2,46	102,16	0,30	97,89	,9727	53	,89476	—	43,50	140,17	3,33	71,34	,7089
4	,82866	—	3,28	102,88	0,40	97,20	,9659	54	,89563	—	44,31	140,95	3,36	70,95	,7050
100 + 5	,83075	—	4,10	103,61	0,49	96,52	,9590	100 + 55	,89649	—	45,13	141,73	3,40	70,56	,7011
6	,83278	—	4,93	104,34	0,59	95,84	,9523	56	,89733	—	45,95	142,51	3,44	70,17	,6973
7	,83477	—	5,75	105,08	0,67	95,17	,9457	57	,89816	—	46,77	143,29	3,48	69,79	,6935
8	,83671	—	6,57	105,81	0,76	94,51	,9391	58	,89898	—	47,59	144,07	3,52	69,40	,6897
9	,83860	—	7,39	106,55	0,84	93,85	,9326	59	,89979	—	48,41	144,85	3,56	69,03	,6859
100 + 10	,84044	—	8,21	107,29	0,92	93,20	,9261	100 + 60	,90058	—	49,24	145,63	3,61	68,66	,6822
11	,84223	—	9,03	108,04	0,99	92,56	,9197	61	,90136	—	50,06	146,42	3,64	68,30	,6786
12	,84398	—	9,85	108,78	1,07	91,93	,9134	62	,90213	—	50,88	147,20	3,68	67,93	,6750
13	,84570	—	10,67	109,53	1,14	91,30	,9072	63	,90289	—	51,70	147,98	3,72	67,57	,6714
14	,84738	—	11,48	110,28	1,20	90,68	,9010	64	,90364	—	52,52	148,77	3,75	67,21	,6679
100 + 15	,84903	—	12,31	111,03	1,28	90,06	,8949	100 + 65	,90438	—	53,34	149,55	3,79	66,86	,6644
16	,85066	—	13,14	111,78	1,36	89,46	,8889	66	,90512	—	54,16	150,33	3,83	66,52	,6609
17	,85226	—	13,95	112,53	1,42	88,86	,8830	67	,90586	—	54,98	151,12	3,86	66,17	,6575
18	,85383	—	14,77	113,29	1,48	88,27	,8771	68	,90659	—	55,80	151,90	3,90	65,83	,6541
19	,85537	—	15,59	114,04	1,55	87,68	,8713	69	,90731	—	56,62	152,68	3,94	65,49	,6507
100 + 20	,85688	—	16,41	114,80	1,61	87,11	,8655	100 + 70	,90801	—	57,45	153,47	3,98	65,15	,6474
21	,85836	—	17,23	115,56	1,67	86,54	,8598	71	,90870	—	58,27	154,26	4,01	64,82	,6441
22	,85982	—	18,05	116,31	1,74	85,97	,8542	72	,90938	—	59,09	155,05	4,04	64,49	,6408
23	,86125	—	18,87	117,07	1,80	85,42	,8488	73	,91005	—	59,91	155,83	4,08	64,17	,6376
24	,86265	—	19,70	117,83	1,87	84,87	,8433	74	,91071	—	60,73	156,62	4,11	63,85	,6344
100 + 25	,86403	—	20,52	118,59	1,93	84,32	,8379	100 + 75	,91135	—	61,55	157,41	4,14	63,53	,6312
26	,86539	—	21,34	119,35	1,99	83,78	,8325	76	,91200	—	62,37	158,19	4,18	63,21	,6281
27	,86672	—	22,16	120,12	2,04	83,25	,8272	77	,91263	—	63,19	158,98	4,21	62,90	,6250
28	,86802	—	22,98	120,88	2,10	82,72	,8220	78	,91325	—	64,01	159,77	4,24	62,59	,6219
29	,86931	—	23,80	121,65	2,15	82,20	,8168	79	,91388	—	64,83	160,56	4,27	62,28	,6188
100 + 30	,87057	—	24,62	122,41	2,21	81,69	,8117	100 + 80	,91449	—	65,65	161,35	4,30	61,98	,6158
31	,87181	—	25,44	123,18	2,26	81,18	,8067	81	,91510	—	66,47	162,14	4,33	61,67	,6128
32	,87303	—	26,26	123,94	2,32	80,68	,8017	82	,91571	—	67,29	162,92	4,37	61,38	,6099
33	,87423	—	27,09	124,71	2,38	80,18	,7968	83	,91631	—	68,11	163,71	4,40	61,08	,6070
34	,87541	—	27,91	125,49	2,42	79,69	,7919	84	,91690	—	68,93	164,50	4,43	60,79	,6040
100 + 35	,87658	—	28,73	126,25	2,48	79,20	,7870	100 + 85	,91749	—	69,75	165,30	4,45	60,50	,6011
36	,87771	—	29,55	127,02	2,53	78,72	,7823	86	,91806	—	70,57	166,09	4,48	60,21	,5983
37	,87882	—	30,37	127,79	2,58	78,25	,7776	87	,91862	—	71,39	166,88	4,51	59,92	,5954
38	,87992	—	31,19	128,56	2,63	77,78	,7719	88	,91917	—	72,22	167,67	4,55	59,64	,5927
39	,88100	—	32,01	129,33	2,68	77,32	,7683	89	,91971	—	73,04	168,46	4,58	59,36	,5899
100 + 40	,88206	—	32,83	130,10	2,73	76,86	,7637	100 + 90	,92025	—	73,86	169,25	4,61	59,08	,5871
41	,88314	—	33,65	130,87	2,78	76,40	,7592	91	,92079	—	74,68	170,04	4,64	58,81	,5844
42	,88419	—	34,47	131,64	2,83	75,96	,7547	92	,92132	—	75,50	170,83	4,67	58,54	,5817
43	,88523	—	35,29	132,42	2,87	75,52	,7503	93	,92185	—	76,32	171,63	4,69	58,27	,5790
44	,88625	—	36,11	133,19	2,92	75,08	,7460	94	,92237	—	77,14	172,42	4,72	58,00	,5764
100 + 45	,88726	—	36,93	133,96	2,97	74,65	,7417	100 + 95	,92289	—	77,96	173,21	4,75	57,73	,5737
46	,88825	—	37,75	134,74	3,01	74,22	,7375	96	,92339	—	78,77	173,99	4,78	57,47	,5711
47	,88922	—	38,57	135,51	3,06	73,79	,7332	97	,92389	—	79,59	174,78	4,81	57,21	,5686
48	,89018	—	39,39	136,29	3,10	73,37	,7291	98	,92439	—	80,41	175,57	4,84	56,95	,5660
49	,89113	—	40,21	137,06	3,15	72,96	,7249	99	,92488	—	81,24	176,37	4,87	56,70	,5634

TABLE II. HEAT 71°.

I. Water and spirit by weight. W. + Sp.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
100 + 100	,92536	100	82,07	177,17	4,90	56,44	,5608
99	,92586	—	82,90	177,97	4,93	56,18	,5583
98	,92636	—	83,75	178,79	4,96	55,92	,5557
97	,92686	—	84,62	179,62	5,00	55,66	,5531
96	,92736	—	85,50	180,47	5,03	55,40	,5506
100 + 95	,92785	—	86,39	181,34	5,05	55,14	,5479
94	,92835	—	87,30	182,23	5,07	54,87	,5453
93	,92884	—	88,24	183,15	5,09	54,60	,5426
92	,92934	—	89,20	184,08	5,12	54,32	,5398
91	,92984	—	90,18	185,03	5,15	54,04	,5370
100 + 90	,93033	—	91,18	186,01	5,17	53,76	,5342
89	,93085	—	92,20	187,01	5,19	53,47	,5314
88	,93138	—	93,25	188,03	5,22	53,18	,5285
87	,93190	—	94,32	189,08	5,24	52,89	,5256
86	,93243	—	95,42	190,14	5,28	52,59	,5226
100 + 85	,93296	—	96,55	191,23	5,32	52,29	,5196
84	,93351	—	97,70	192,35	5,35	51,99	,5166
83	,93406	—	98,87	193,50	5,37	51,68	,5135
82	,93462	—	100,08	194,67	5,41	51,37	,5104
81	,93518	—	101,32	195,87	5,45	51,05	,5073
100 + 80	,93576	—	102,59	197,10	5,49	50,73	,5041
79	,93632	—	103,89	198,36	5,53	50,41	,5009
78	,93688	—	105,22	199,67	5,55	50,08	,4976
77	,93744	—	106,59	201,01	5,58	49,75	,4943
76	,93801	—	107,99	202,39	5,60	49,41	,4910
100 + 75	,93857	—	109,43	203,80	5,63	49,07	,4876
74	,93916	—	110,90	205,24	5,66	48,72	,4842
73	,93975	—	112,41	206,72	5,69	48,37	,4807
72	,94034	—	113,98	208,25	5,73	48,01	,4772
71	,94093	—	115,59	209,82	5,77	47,66	,4736
100 + 70	,94153	—	117,24	211,44	5,80	47,29	,4699
69	,94214	—	118,93	213,10	5,83	46,92	,4662
68	,94275	—	120,68	214,82	5,86	46,55	,4625
67	,94336	—	122,49	216,60	5,89	46,17	,4588
66	,94398	—	124,34	218,41	5,93	45,79	,4550
100 + 65	,94461	—	126,26	220,29	5,97	45,39	,4511
64	,94523	—	128,23	222,23	6,00	44,99	,4472
63	,94585	—	130,26	224,23	6,03	44,59	,4432
62	,94649	—	132,36	226,30	6,06	44,19	,4391
61	,94712	—	134,53	228,43	6,10	43,78	,4350
100 + 60	,94775	—	136,78	230,64	6,14	43,36	,4308
59	,94840	—	139,09	232,93	6,16	42,93	,4266
58	,94905	—	141,49	235,30	6,19	42,50	,4224
57	,94971	—	143,98	237,75	6,23	42,06	,4180
56	,95037	—	146,56	240,29	6,27	41,61	,4136
100 + 55	,95102	—	149,21	242,91	6,30	41,17	,4091
54	,95169	—	151,95	245,63	6,32	40,71	,4045
53	,95234	—	154,80	248,47	6,33	40,24	,3999
52	,95301	—	157,80	251,42	6,38	39,77	,3952
51	,95368	—	160,90	254,50	6,40	39,29	,3904
100 + 50	,95433	100	164,13	257,70	6,43	38,81	,3856
49	,95501	—	167,49	261,01	6,48	38,31	,3807
48	,95567	—	170,98	264,47	6,51	37,81	,3757
47	,95635	—	174,61	268,09	6,52	37,30	,3706
46	,95702	—	178,41	271,86	6,55	36,78	,3655
100 + 45	,95770	—	182,38	275,81	6,57	36,25	,3603
44	,95838	—	186,52	279,93	6,59	35,72	,3550
43	,95906	—	190,86	284,25	6,61	35,17	,3496
42	,95975	—	195,41	288,79	6,62	34,62	,3441
41	,96043	—	200,17	293,54	6,63	34,06	,3385
100 + 40	,96111	—	205,17	298,52	6,65	33,49	,3329
39	,96181	—	210,44	303,77	6,67	32,92	,3271
38	,96249	—	215,97	309,31	6,66	32,33	,3213
37	,96318	—	221,81	315,15	6,66	31,73	,3153
36	,96387	—	227,97	321,31	6,66	31,12	,3093
100 + 35	,96456	—	234,49	327,80	6,69	30,51	,3031
34	,96526	—	241,38	334,70	6,68	29,87	,2969
33	,96596	—	248,70	342,04	6,66	29,23	,2905
32	,96668	—	256,47	349,83	6,64	28,58	,2840
31	,96739	—	264,74	358,11	6,63	27,92	,2774
100 + 30	,96811	—	273,57	366,92	6,65	27,25	,2708
29	,96883	—	283,00	376,38	6,62	26,57	,2640
28	,96956	—	293,11	386,54	6,57	25,87	,2571
27	,97030	—	303,96	397,43	6,53	25,16	,2501
26	,97105	—	315,66	409,15	6,51	24,44	,2429
100 + 25	,97180	—	328,28	421,77	6,52	23,71	,2356
24	,97257	—	341,96	435,48	6,48	22,96	,2282
23	,97334	—	356,83	450,39	6,44	22,20	,2207
22	,97414	—	373,05	466,65	6,40	21,43	,2130
21	,97495	—	390,81	484,46	6,35	20,64	,2051
100 + 20	,97575	—	410,36	504,06	6,30	19,84	,1971
19	,97659	—	431,95	525,72	6,23	19,02	,1890
18	,97744	—	455,95	549,79	6,16	18,19	,1807
17	,97831	—	482,77	576,68	6,09	17,34	,1723
16	,97920	—	512,95	606,93	6,02	16,48	,1637
100 + 15	,98011	—	547,14	641,22	5,92	15,60	,1550
14	,98105	—	586,22	680,41	5,81	14,70	,1461
13	,98201	—	631,31	725,59	5,72	13,78	,1370
12	,98302	—	683,93	778,31	5,62	12,85	,1277
11	,98405	—	746,10	840,60	5,50	11,89	,1182
100 + 10	,98513	—	820,71	915,31	5,40	10,92	,1086
9	,98624	—	911,90	1006,65	5,25	9,93	,0987
8	,98740	—	1025,89	1120,77	5,12	8,92	,0887
7	,98862	—	1173,46	1267,46	5,00	7,89	,0784
6	,99089	—	1367,86	1463,01	4,85	6,84	,0679
100 + 5	,99121	—	1641,43	1736,73	4,70	5,76	,0572
4	,99259	—	2051,79	2147,26	4,53	4,66	,0463
3	,99404	—	2735,73	2834,34	4,39	3,53	,0351
2	,99557	—	4103,59	4199,35	4,24	2,38	,0237
1	,99716	—	8207,17	8303,07	4,10	1,21	,0120

TABLE I. HEAT 72°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81927	100	—	100,00	—	100,00	,9930
1	,82157	—	0,82	100,72	0,10	99,29	,9860
2	,82383	—	1,64	101,44	0,20	98,58	,9790
3	,82603	—	2,46	102,16	0,30	97,89	,9721
4	,82817	—	3,28	102,88	0,40	97,20	,9653
100 + 5	,83026	—	4,10	103,61	0,49	96,52	,9585
6	,83229	—	4,92	104,34	0,58	95,84	,9518
7	,83428	—	5,74	105,08	0,66	95,17	,9452
8	,83623	—	6,56	105,81	0,75	94,51	,9386
9	,83812	—	7,39	106,55	0,84	93,85	,9321
100 + 10	,83995	—	8,20	107,29	0,91	93,20	,9256
11	,84175	—	9,02	108,04	0,98	92,56	,9192
12	,84350	—	9,84	108,78	1,06	91,93	,9129
13	,84522	—	10,66	109,53	1,13	91,30	,9067
14	,84690	—	11,48	110,28	1,20	90,68	,9005
100 + 15	,84854	—	12,31	111,03	1,28	90,06	,8944
16	,85018	—	13,13	111,78	1,35	89,46	,8885
17	,85177	—	13,95	112,53	1,42	88,86	,8825
18	,85334	—	14,76	113,29	1,47	88,27	,8766
19	,85489	—	15,58	114,04	1,54	87,68	,8708
100 + 20	,85640	—	16,40	114,80	1,60	87,11	,8650
21	,85788	—	17,22	115,55	1,67	86,54	,8594
22	,85933	—	18,04	116,30	1,74	85,98	,8537
23	,86077	—	18,86	117,06	1,80	85,42	,8483
24	,86217	—	19,69	117,82	1,87	84,87	,8429
100 + 25	,86356	—	20,51	118,59	1,92	84,33	,8374
26	,86491	—	21,33	119,35	1,98	83,79	,8321
27	,86624	—	22,15	120,11	2,04	83,26	,8268
28	,86754	—	22,97	120,88	2,09	82,73	,8216
29	,86883	—	23,79	121,64	2,15	82,21	,8164
100 + 30	,87008	—	24,61	122,40	2,21	81,70	,8113
31	,87133	—	25,43	123,17	2,26	81,19	,8062
32	,87255	—	26,25	123,94	2,31	80,69	,8013
33	,87375	—	27,07	124,71	2,36	80,19	,7963
34	,87494	—	27,89	125,48	2,41	79,70	,7914
100 + 35	,87610	—	28,71	126,24	2,47	79,21	,7866
36	,87724	—	29,53	127,01	2,52	78,73	,7819
37	,87835	—	30,35	127,78	2,57	78,26	,7772
38	,87944	—	31,17	128,55	2,62	77,79	,7715
39	,88053	—	31,99	129,33	2,66	77,33	,7679
100 + 40	,88159	—	32,81	130,10	2,71	76,87	,7633
41	,88267	—	33,63	130,87	2,76	76,41	,7588
42	,88372	—	34,46	131,64	2,82	75,96	,7543
43	,88476	—	35,27	132,41	2,86	75,52	,7499
44	,88578	—	36,09	133,18	2,91	75,08	,7456
100 + 45	,88679	—	36,91	133,95	2,96	74,65	,7413
46	,88778	—	37,73	134,73	3,00	74,22	,7371
47	,88875	—	38,55	135,50	3,05	73,80	,7329
48	,88971	—	39,37	136,28	3,09	73,38	,7287
49	,89066	—	40,19	137,05	3,14	72,96	,7246

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89159	100	41,01	137,83	3,18	72,55	,7205
51	,89250	—	41,84	138,61	3,23	72,15	,7165
52	,89341	—	42,66	139,39	3,27	71,74	,7125
53	,89430	—	43,48	140,16	3,32	71,34	,7085
54	,89517	—	44,29	140,94	3,35	70,95	,7046
100 + 55	,89602	—	45,11	141,72	3,39	70,56	,7007
56	,89687	—	45,93	142,50	3,43	70,17	,6969
57	,89770	—	46,75	143,28	3,47	69,79	,6931
58	,89852	—	47,57	144,06	3,51	69,41	,6893
59	,89933	—	48,39	144,84	3,55	69,04	,6855
100 + 60	,90011	—	49,22	145,62	3,60	68,67	,6819
61	,90090	—	50,04	146,41	3,63	68,30	,6782
62	,90166	—	50,86	147,19	3,67	67,93	,6746
63	,90242	—	51,68	147,97	3,71	67,57	,6710
64	,90317	—	52,50	148,76	3,74	67,22	,6675
100 + 65	,90391	—	53,32	149,54	3,78	66,87	,6640
66	,90466	—	54,14	150,32	3,82	66,52	,6606
67	,90540	—	54,96	151,11	3,85	66,17	,6572
68	,90613	—	55,78	151,89	3,89	65,83	,6538
69	,90685	—	56,60	152,67	3,93	65,50	,6504
100 + 70	,90755	—	57,42	153,46	3,96	65,16	,6471
71	,90824	—	58,24	154,25	3,99	64,83	,6438
72	,90892	—	59,06	155,03	4,03	64,50	,6405
73	,90959	—	59,88	155,82	4,06	64,17	,6373
74	,91025	—	60,70	156,61	4,09	63,85	,6341
100 + 75	,91090	—	61,52	157,39	4,13	63,53	,6309
76	,91155	—	62,34	158,18	4,16	63,22	,6278
77	,91218	—	63,16	158,96	4,20	62,90	,6247
78	,91280	—	63,98	159,76	4,22	62,59	,6216
79	,91343	—	64,80	160,55	4,25	62,29	,6185
100 + 80	,91405	—	65,62	161,34	4,28	61,98	,6155
81	,91466	—	66,44	162,13	4,31	61,68	,6125
82	,91527	—	67,26	162,91	4,35	61,38	,6095
83	,91587	—	68,08	163,69	4,39	61,09	,6067
84	,91646	—	68,90	164,49	4,41	60,79	,6038
100 + 85	,91704	—	69,72	165,28	4,44	60,50	,6009
86	,91761	—	70,54	166,07	4,47	60,22	,5980
87	,91818	—	71,36	166,86	4,50	59,93	,5952
88	,91873	—	72,19	167,65	4,54	59,65	,5924
89	,91927	—	73,01	168,44	4,57	59,37	,5896
100 + 90	,91981	—	73,83	169,23	4,60	59,09	,5868
91	,92035	—	74,65	170,02	4,63	58,82	,5841
92	,92088	—	75,47	170,81	4,66	58,54	,5814
93	,92141	—	76,29	171,61	4,68	58,27	,5787
94	,92193	—	77,11	172,40	4,71	58,01	,5760
100 + 95	,92244	—	77,93	173,19	4,74	57,74	,5734
96	,92295	—	78,73	173,97	4,76	57,48	,5709
97	,92345	—	79,55	174,76	4,79	57,22	,5683
98	,92395	—	80,37	175,55	4,82	56,96	,5657
99	,92445	—	81,20	176,35	4,85	56,71	,5631

TABLE II. HEAT 72°.

I. Water and spirit by weight. W. + Sp.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
100 + 100	,92493	100	82,03	177,15	4,88	56.45	,5605
99	,92543	—	82,86	177,95	4,91	56,19	,5580
98	,92593	—	83,71	178,77	4,94	55,93	,5555
97	,92643	—	84,58	179,60	4,98	55,67	,5529
96	,92693	—	85,46	180.45	5,01	55,41	,5503
100 + 95	,92742	—	86,35	181,32	5,03	55,15	,5476
94	,92792	—	87,26	182,20	5,06	54,88	,5450
93	,92841	—	88,20	183,13	5,07	54,61	,5423
92	,92891	—	89,16	184,06	5,10	54,33	,5395
91	,92941	—	90,14	185,01	5,13	54,05	,5367
100 + 90	,92991	—	91,14	185,99	5,15	53,77	,5339
89	,93043	—	92,16	186,98	5,18	53,48	,5311
88	,93096	—	93,21	188,01	5,20	53,19	,5282
87	,93148	—	94,28	189,05	5,23	52,90	,5253
86	,93201	—	95,38	190,11	5,27	52,60	,5224
100 + 85	,93255	—	96,51	191,20	5,31	52,30	,5194
84	,93311	—	97,66	192,32	5,34	52,00	,5164
83	,93366	—	98,83	193,47	5,36	51,69	,5133
82	,93422	—	100,04	194,64	5,40	51,37	,5102
81	,93478	—	101,28	195,84	5,44	51,06	,5071
100 + 80	,93536	—	102,54	197,07	5,47	50,74	,5039
79	,93591	—	103,84	198,33	5,51	50,41	,5007
78	,93647	—	105,17	199,64	5,53	50,08	,4974
77	,93703	—	106,54	200,98	5,56	49,75	,4941
76	,93760	—	107,94	202,35	5,59	49,42	,4908
100 + 75	,93816	—	109,38	203,76	5,62	49,08	,4874
74	,93875	—	110,85	205,21	5,64	48,73	,4840
73	,93934	—	112,36	206,69	5,67	48,38	,4805
72	,93993	—	113,92	208,22	5,70	48,02	,4770
71	,94052	—	115,53	209,79	5,74	47,67	,4734
100 + 70	,94112	—	117,19	211,41	5,78	47,30	,4697
69	,94173	—	118,87	213,07	5,80	46,93	,4660
68	,94234	—	120,62	214,79	5,83	46,55	,4623
67	,94295	—	122,43	216,56	5,87	46,18	,4586
66	,94358	—	124,28	218,38	5,90	45,79	,4548
100 + 65	,94421	—	126,20	220,25	5,95	45,40	,4509
64	,94483	—	128,17	222,19	5,98	45,00	,4470
63	,94546	—	130,20	224,19	6,01	44,60	,4430
62	,94610	—	132,30	226,26	6,04	44,20	,4389
61	,94674	—	134,47	228,39	6,08	43,79	,4348
100 + 60	,94737	—	136,71	230,60	6,11	43,37	,4306
59	,94802	—	139,03	232,88	6,15	42,94	,4264
58	,94868	—	141,42	235,25	6,17	42,50	,4221
57	,94934	—	143,91	237,70	6,21	42,07	,4178
56	,95000	—	146,49	240,24	6,25	41,62	,4134
100 + 55	,95065	—	149,14	242,86	6,28	41,17	,4089
54	,95132	—	151,88	245,58	6,30	40,71	,4043
53	,95198	—	154,73	248,42	6,31	40,25	,3997
52	,95265	—	157,72	251,37	6,35	39,78	,3950
51	,95332	—	160,83	254,45	6,38	39,30	,3902

I. Water and spirit by weight. W. + Sp.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
100 + 50	,95397	100	164,05	257,64	6,41	38,81	,3854
49	,95466	—	167,41	260,95	6,46	38,32	,3805
48	,95533	—	170,90	264,41	6,49	37,81	,3755
47	,95601	—	174,53	268,03	6,50	37,30	,3705
46	,95669	—	178,32	271,79	6,53	36,79	,3654
100 + 45	,95737	—	182,29	275,74	6,55	36,26	,3601
44	,95805	—	186,44	279,86	6,58	35,73	,3549
43	,95874	—	190,77	284,18	6,59	35,18	,3495
42	,95943	—	195,32	288,71	6,61	34,63	,3440
41	,96011	—	200,08	293,46	6,62	34,07	,3384
100 + 40	,96080	—	205,07	298,44	6,63	33,50	,3327
39	,96150	—	210,34	303,69	6,65	32,93	,3270
38	,96219	—	215,87	309,22	6,65	32,34	,3212
37	,96288	—	221,71	315,05	6,66	31,74	,3152
36	,96358	—	227,86	321,20	6,66	31,13	,3092
100 + 35	,96428	—	234,38	327,70	6,68	30,51	,3030
34	,96498	—	241,27	334,59	6,68	29,88	,2968
33	,96569	—	248,58	341,93	6,65	29,24	,2904
32	,96641	—	256,35	349,72	6,63	28,59	,2839
31	,96713	—	264,62	357,99	6,63	27,93	,2774
100 + 30	,96786	—	273,44	366,80	6,64	27,26	,2707
29	,96858	—	282,87	376,25	6,62	26,58	,2639
28	,96931	—	292,97	386,40	6,57	25,88	,2570
27	,97006	—	303,82	397,29	6,53	25,17	,2500
26	,97081	—	315,51	409,00	6,51	24,45	,2428
100 + 25	,97157	—	328,13	421,62	6,51	23,72	,2355
24	,97234	—	341,80	435,32	6,48	22,97	,2281
23	,97312	—	356,66	450,22	6,44	22,21	,2206
22	,97392	—	372,87	466,47	6,40	21,44	,2129
21	,97474	—	390,63	484,27	6,36	20,65	,2050
100 + 20	,97555	—	410,17	503,86	6,31	19,85	,1971
19	,97639	—	431,75	525,51	6,24	19,03	,1890
18	,97725	—	455,74	549,57	6,17	18,20	,1807
17	,97813	—	482,54	576,44	6,10	17,35	,1723
16	,97902	—	512,71	606,68	6,03	16,48	,1637
100 + 15	,97994	—	546,88	640,95	5,93	15,60	,1549
14	,98088	—	585,95	680,12	5,83	14,70	,1460
13	,98187	—	631,02	725,28	5,74	13,79	,1369
12	,98286	—	683,61	777,97	5,64	12,85	,1276
11	,98390	—	745,76	840,23	5,53	11,90	,1182
100 + 10	,98499	—	820,33	914,90	5,43	10,93	,1085
9	,98610	—	911,47	1006,20	5,27	9,94	,0987
8	,98726	—	1025,41	1120,26	5,15	8,93	,0887
7	,98848	—	1172,92	1266,88	5,04	7,89	,0784
6	,99075	—	1367,22	1462,34	4,88	6,84	,0679
100 + 5	,99108	—	1640,67	1735,93	4,74	5,76	,0572
4	,99245	—	2050,83	2146,27	4,56	4,66	,0463
3	,99391	—	2734,46	2830,04	4,42	3,53	,0351
2	,99544	—	4101,68	4197,41	4,27	2,38	,0237
1	,99704	—	8203,36	8299,21	4,15	1,21	,0120

TABLE I. HEAT 73°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81878	100	—	100,00	—	100,00	,9924
1	,82108	—	0,82	100,72	0,10	99,29	,9854
2	,82334	—	1,64	101,44	0,20	98,58	,9784
3	,82553	—	2,46	102,16	0,30	97,89	,9715
4	,82768	—	3.28	102,88	0,40	97,20	,9647
100 + 5	,82977	—	4,10	103,61	0,49	96,52	,9579
6	,83180	—	4,92	104,34	0,58	95,84	,9512
7	,83379	—	5,74	105,08	0,66	95,17	,9446
8	,83574	—	6,56	105,81	0,75	94,51	,9380
9	,83764	—	7,38	106,55	0,83	93,85	,9315
100 + 10	,83947	—	8,20	107,29	0,91	93,21	,9250
11	,84127	—	9,02	108,03	0,99	92,57	,9186
12	,84302	—	9,84	108,78	1,06	91,93	,9123
13	,84474	—	10,66	109,53	1,13	91,30	,9061
14	,84642	—	11,48	110,28	1,20	90,68	,9000
100 + 15	,84806	—	12,30	111,02	1,28	90,07	,8939
16	,84970	—	13,12	111,78	1,34	89,46	,8879
17	,85129	—	13,94	112,53	1,41	88,87	,8820
18	,85286	—	14,76	113,28	1,48	88,27	,8761
19	,85440	—	15,58	114,04	1,54	87,69	,8703
100 + 20	,85592	—	16,39	114,80	1,59	87,11	,8646
21	,85740	—	17,21	115,55	1,66	86,54	,8589
22	,85885	—	18,04	116,30	1,74	85,98	,8533
23	,86029	—	18,86	117,06	1,80	85,42	,8478
24	,86169	—	19,68	117,82	1,86	84,87	,8423
100 + 25	,86308	—	20,50	118,58	1,92	84,33	,8369
26	,86443	—	21,32	119,34	1,98	83,79	,8316
27	,86576	—	22,14	120,11	2,03	83,26	,8263
28	,86706	—	22,96	120,87	2,09	82,73	,8211
29	,86835	—	23,78	121,63	2,15	82,21	,8159
100 + 30	,86960	—	24,60	122,40	2,20	81,70	,8108
31	,87085	—	25,41	123,17	2,24	81,19	,8058
32	,87207	—	26,23	123,93	2,30	80,69	,8009
33	,87327	—	27,06	124,70	2,36	80,19	,7959
34	,87446	—	27,88	125,47	2,41	79,70	,7910
100 + 35	,87562	—	28,70	126,23	2,47	79,21	,7862
36	,87676	—	29,52	127,00	2,52	78,73	,7815
37	,87788	—	30,34	127,78	2,56	78,26	,7768
38	,87897	—	31,16	128,55	2,61	77,79	,7711
39	,88006	—	31,98	129,32	2,66	77,33	,7675
100 + 40	,88112	—	32,80	130,09	2,71	76,87	,7629
41	,88220	—	33,61	130,86	2,75	76,41	,7584
42	,88325	—	34,44	131,63	2,81	75,97	,7539
43	,88429	—	35,26	132,41	2,85	75,53	,7495
44	,88531	—	36,08	133,17	2,91	75,09	,7452
100 + 45	,88632	—	36,90	133,94	2,96	74,66	,7409
46	,88731	—	37,71	134,72	2,99	74,23	,7367
47	,88828	—	38,53	135,49	3,04	73,80	,7325
48	,88924	—	39,35	136,27	3,08	73,38	,7283
49	,89019	—	40,17	137,04	3,13	72,97	,7242

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89112	100	40,99	137,82	3,17	72,56	,7201
51	,89204	—	41,82	138,60	3,22	72,15	,7161
52	,89294	—	42,64	139,38	3,26	71,75	,7121
53	,89383	—	43,46	140,15	3,31	71,35	,7082
54	,89471	—	44,27	140,93	3,34	70,96	,7042
100 + 55	,89556	—	45,09	141,71	3,38	70,57	,7003
56	,89641	—	45,91	142,49	3,42	70,18	,6965
57	,89724	—	46,73	143,27	3,46	69,80	,6927
58	,89806	—	47,55	144,05	3,50	69,42	,6889
59	,89887	—	48,37	144,83	3,54	69,04	,6852
100 + 60	,89964	—	49,19	145,61	3,58	68,67	,6815
61	,90043	—	50,01	146,40	3,61	68,31	,6779
62	,90120	—	50,83	147,18	3,65	67,94	,6743
63	,90196	—	51,65	147,96	3,69	67,58	,6707
64	,90271	—	52,47	148,75	3,72	67,23	,6672
100 + 65	,90345	—	53,29	149,53	3,76	66,88	,6637
66	,90420	—	54,11	150,31	3,80	66,53	,6602
67	,90494	—	54,93	151,09	3,84	66,18	,6568
68	,90567	—	55,75	151,87	3,88	65,84	,6534
69	,90639	—	56,57	152,65	3,92	65,51	,6501
100 + 70	,90709	—	57,39	153,44	3,95	65,17	,6468
71	,90778	—	58,22	154,23	3,99	64,84	,6435
72	,90846	—	59,03	155,01	4,02	64,51	,6402
73	,90913	—	59,85	155,80	4,05	64,18	,6370
74	,90979	—	60,67	156,59	4,08	63,86	,6338
100 + 75	,91044	—	61,49	157,38	4,11	63,54	,6306
76	,91109	—	62,31	158,16	4,15	63,23	,6275
77	,91173	—	63,13	158,95	4,18	62,91	,6244
78	,91235	—	63,95	159,74	4,21	62,60	,6213
79	,91298	—	64,77	160,53	4,24	62,29	,6182
100 + 80	,91360	—	65,59	161,32	4,27	61,99	,6152
81	,91421	—	66,41	162,11	4,30	61,69	,6122
82	,91482	—	67,23	162,89	4,34	61,39	,6092
83	,91542	—	68,05	163,68	4,37	61,10	,6064
84	,91601	—	68,87	164,47	4,40	60,80	,6035
100 + 85	,91659	—	69,69	165,26	4,43	60,51	,6006
86	,91716	—	70,51	166,05	4,46	60,22	,5977
87	,91773	—	71,33	166,84	4,49	59,94	,5949
88	,91829	—	72,15	167,63	4,52	59,66	,5921
89	,91883	—	72,97	168,42	4,55	59,38	,5893
100 + 90	,91937	—	73,79	169,21	4,58	59,10	,5865
91	,91991	—	74,61	170,00	4,61	58,82	,5838
92	,92044	—	75,43	170,79	4,64	58,55	,5811
93	,92097	—	76,25	171,59	4,66	58,28	,5784
94	,92149	—	77,07	172,38	4,69	58,01	,5758
100 + 95	,92199	—	77,89	173,17	4,72	57,75	,5731
96	,92251	—	78,70	173,95	4,75	57,49	,5706
97	,92301	—	79,52	174,74	4,78	57,23	,5680
98	,92351	—	80,33	175,53	4,80	56,97	,5654
99	,92402	—	81,16	176,33	4,83	56,71	,5629

TABLE II. HEAT 73°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,92450	100	81,99	177,13	4,86	56,45	,5603
99	,92500	—	82,82	177,93	4,89	56,20	,5578
98	,92550	—	83,67	178,75	4,92	55,94	,5552
97	,92600	—	84,54	179,58	4,96	55,68	,5526
96	,92650	—	85,42	180,43	4,99	55,41	,5500
100 + 95	,92699	—	86,31	181,29	5,02	55,15	,5474
94	,92749	—	87,22	182,18	5,04	54,88	,5447
93	,92798	—	88,16	183,10	5,06	54,61	,5420
92	,92848	—	89,12	184,03	5,09	54,33	,5393
91	,92899	—	90,10	184,98	5,12	54,05	,5365
100 + 90	,92949	—	91,10	185,96	5,14	53,77	,5337
89	,93001	—	92,12	186,95	5,17	53,48	,5309
88	,93054	—	93,17	187,98	5,19	53,19	,5280
87	,93106	—	94,24	189,02	5,22	52,90	,5251
86	,93160	—	95,33	190,08	5,25	52,61	,5222
100 + 85	,93214	—	96,46	191,17	5,29	52,31	,5191
84	,93270	—	97,61	192,29	5,32	52,01	,5161
83	,93325	—	98,78	193,44	5,34	51,70	,5131
82	,93381	—	99,99	194,61	5,38	51,38	,5100
81	,93437	—	101,23	195,81	5,42	51,07	,5069
100 + 80	,93495	—	102,49	197,04	5,45	50,75	,5037
79	,93550	—	103,79	198,30	5,49	50,42	,5005
78	,93606	—	105,12	199,61	5,51	50,09	,4972
77	,93662	—	106,49	200,94	5,55	49,76	,4939
76	,93719	—	107,89	202,32	5,57	49,43	,4906
100 + 75	,93775	—	109,33	203,73	5,60	49,09	,4872
74	,93834	—	110,80	205,18	5,62	48,74	,4838
73	,93893	—	112,31	206,65	5,66	48,39	,4803
72	,93952	—	113,87	208,18	5,69	48,03	,4768
71	,94011	—	115,48	209,76	5,72	47,67	,4732
100 + 70	,94071	—	117,13	211,37	5,76	47,31	,4695
69	,94132	—	118,82	213,03	5,79	46,94	,4658
68	,94193	—	120,57	214,76	5,81	46,56	,4621
67	,94255	—	122,37	216,52	5,85	46,18	,4584
66	,94318	—	124,22	218,34	5,88	45,80	,4546
100 + 65	,94381	—	126,14	220,21	5,93	45,41	,4507
64	,94443	—	128,11	222,15	5,96	45,01	,4468
63	,94507	—	130,14	224,15	5,99	44,61	,4428
62	,94571	—	132,24	226,22	6,02	44,20	,4387
61	,94635	—	134,41	228,35	6,06	43,79	,4346
100 + 60	,94699	—	136,65	230,55	6,10	43,37	,4304
59	,94764	—	138,97	232,84	6,13	42,94	,4262
58	,94831	—	141,36	235,20	6,16	42,51	,4220
57	,94897	—	143,84	237,65	6,19	42,07	,4176
56	,94963	—	146,42	240,19	6,23	41,63	,4132
100 + 55	,95029	—	149,07	242,81	6,26	41,18	,4087
54	,95096	—	151,81	245,53	6,28	40,72	,4042
53	,95162	—	154,66	248,37	6,29	40,26	,3996
52	,95229	—	157,64	251,31	6,34	39,79	,3949
51	,95296	—	160,76	254,40	6,36	39,31	,3901

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95362	100	163,98	257,58	6,40	38,82	,3853
49	,95431	—	167,33	260,89	6,44	38,33	,3803
48	,95499	—	170,82	264,35	6,47	37,82	,3753
47	,95567	—	174,45	267,97	6,48	37,31	,3703
46	,95636	—	178,24	271,73	6,51	36,80	,3652
100 + 45	,95704	—	182,21	275,67	6,54	36,27	,3600
44	,95772	—	186,35	279,79	6,56	35,74	,3548
43	,95842	—	190,68	284,11	6,57	35,19	,3494
42	,95911	—	195,23	288,64	6,59	34,64	,3439
41	,95980	—	199,99	293,38	6,61	34,08	,3383
100 + 40	,96049	—	204,98	298,36	6,62	33,51	,3326
39	,96119	—	210,24	303,60	6,64	32,94	,3269
38	,96189	—	215,77	309,13	6,64	32,35	,3211
37	,96259	—	221,60	314,96	6,64	31,75	,3151
36	,96329	—	227,75	321,10	6,65	31,14	,3091
100 + 35	,96400	—	234,27	327,60	6,67	30,52	,3029
34	,96471	—	241,16	334,49	6,67	29,89	,2967
33	,96542	—	248,46	341,82	6,64	29,25	,2904
32	,96614	—	256,23	349,60	6,63	28,60	,2839
31	,96687	—	264,50	357,87	6,63	27,94	,2773
100 + 30	,96760	—	273,31	366,68	6,63	27,27	,2706
29	,96833	—	282,74	376,13	6,61	26,59	,2639
28	,96907	—	292,83	386,26	6,57	25,89	,2569
27	,96982	—	303,68	397,14	6,54	25,18	,2499
26	,97057	—	315,36	408,85	6,51	24,46	,2428
100 + 25	,97134	—	327,98	421,47	6,51	23,73	,2355
24	,97211	—	341,64	435,16	6,48	22,98	,2281
23	,97290	—	356,49	450,05	6,44	22,22	,2205
22	,97371	—	372,70	466,30	6,40	21,44	,2128
21	,97453	—	390,45	484,09	6,36	20,65	,2050
100 + 20	,97535	—	409,98	503,67	6,31	19,85	,1970
19	,97620	—	431,55	525,30	6,25	19,04	,1889
18	,97706	—	455,53	549,35	6,18	18,20	,1806
17	,97795	—	482,32	576,20	6,12	17,35	,1722
16	,97885	—	512,47	606,43	6,04	16,49	,1636
100 + 15	,97977	—	546,63	640,68	5,95	15,61	,1549
14	,98072	—	585,68	679,83	5,85	14,71	,1460
13	,98172	—	630,73	724,97	5,76	13,79	,1369
12	,98271	—	683,29	777,63	5,66	12,86	,1276
11	,98375	—	745,41	839,86	5,55	11,90	,1182
100 + 10	,98484	—	819,95	914,49	5,46	10,93	,1085
9	,98596	—	911,05	1005,75	5,30	9,94	,0987
8	,98712	—	1024,93	1119,76	5,17	8,93	,0886
7	,98834	—	1172,39	1266,31	5,08	7,90	,0784
6	,99061	—	1366,58	1461,68	4,90	6,84	,0679
100 + 5	,99094	—	1639,91	1735,13	4,78	5,76	,0572
4	,99231	—	2049,88	2145,29	4,59	4,66	,0463
3	,99378	—	2733,18	2828,73	4,45	3,53	,0351
2	,99531	—	4099,78	4195,47	4,31	2,38	,0237
1	,99691	—	8199,55	8295,35	4,20	1,21	,0120

TABLE I. HEAT 74°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81829	100	—	100,00	—	100,00	,9919
1	,82059	—	0,82	100,72	0,10	99,29	,9848
2	,82284	—	1,64	101,44	0,20	98,58	,9778
3	,82504	—	2,46	102,16	0,30	97,89	,9709
4	,82719	—	3,28	102,88	0,40	97,20	,9641
100 + 5	,82927	—	4,10	103,61	0,49	96,52	,9573
6	,83131	—	4,92	104,34	0,58	95,84	,9506
7	,83330	—	5,74	105,07	0,66	95,17	,9440
8	,83525	—	6,56	105,81	0,75	94,51	,9374
9	,83715	—	7,38	106,54	0,84	93,86	,9309
100 + 10	,83899	—	8,20	107,28	0,92	93,21	,9245
11	,84079	—	9,01	108,03	0,98	92,57	,9181
12	,84254	—	9,83	108,78	1,05	91,93	,9118
13	,84426	—	10,65	109,52	1,13	91,30	,9056
14	,84594	—	11,47	110,27	1,20	90,68	,8995
100 + 15	,84758	—	12,30	111,02	1,28	90,07	,8934
16	,84921	—	13,12	111,77	1,35	89,47	,8874
17	,85080	—	13,93	112,52	1,41	88,87	,8815
18	,85237	—	14,75	113,28	1,47	88,28	,8756
19	,85391	—	15,57	114,03	1,54	87,69	,8698
100 + 20	,85544	—	16,39	114,79	1,60	87,11	,8641
21	,85691	—	17,20	115,54	1,66	86,54	,8584
22	,85837	—	18,03	116,30	1,73	85,98	,8528
23	,85981	—	18,85	117,05	1,80	85,43	,8473
24	,86121	—	19,67	117,81	1,86	84,88	,8419
100 + 25	,86260	—	20,49	118,58	1,91	84,33	,8365
26	,86395	—	21,31	119,34	1,97	83,79	,8311
27	,86528	—	22,13	120,10	2,03	83,26	,8258
28	,86658	—	22,95	120,87	2,08	82,74	,8206
29	,86787	—	23,77	121,63	2,14	82,22	,8155
100 + 30	,86912	—	24,59	122,39	2,20	81,70	,8104
31	,87037	—	25,40	123,16	2,24	81,19	,8053
32	,87159	—	26,22	123,93	2,29	80,69	,8004
33	,87279	—	27,04	124,70	2,34	80,20	,7954
34	,87398	—	27,86	125,47	2,39	79,71	,7906
100 + 35	,87514	—	28,68	126,23	2,45	79,22	,7858
36	,87628	—	29,50	127,00	2,50	78,74	,7811
37	,87740	—	30,32	127,77	2,55	78,27	,7764
38	,87850	—	31,15	128,54	2,61	77,80	,7707
39	,87959	—	31,96	129,31	2,65	77,33	,7671
100 + 40	,88065	—	32,78	130,09	2,69	76,87	,7625
41	,88173	—	33,60	130,86	2,74	76,42	,7580
42	,88278	—	34,43	131,63	2,80	75,97	,7535
43	,88382	—	35,24	132,40	2,84	75,53	,7491
44	,88484	—	36,06	133,17	2,89	75,09	,7448
100 + 45	,88585	—	36,88	133,94	2,94	74,66	,7405
46	,88684	—	37,69	134,71	2,98	74,23	,7363
47	,88781	—	38,51	135,49	3,02	73,81	,7321
48	,88877	—	39,33	136,26	3,07	73,39	,7279
49	,88972	—	40,15	137,03	3,12	72,97	,7238

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89065	100	40,97	137,81	3,16	72,56	,7197
51	,89157	—	41,80	138,59	3,21	72,16	,7157
52	,89248	—	42,62	139,37	3,25	71,75	,7117
53	,89337	—	43,44	140,14	3,30	71,35	,7078
54	,89425	—	44,25	140,92	3,33	70,96	,7039
100 + 55	,89510	—	45,07	141,70	3,37	70,57	,7000
56	,89595	—	45,89	142,48	3,41	70,18	,6962
57	,89678	—	46,71	143,26	3,45	69,80	,6924
58	,89760	—	47,53	144,04	3,49	69,42	,6886
59	,89840	—	48,35	144,82	3,53	69,05	,6849
100 + 60	,89918	—	49,17	145,60	3,57	68,68	,6812
61	,89997	—	49,99	146,39	3,60	68,31	,6776
62	,90073	—	50,81	147,17	3,64	67,94	,6739
63	,90149	—	51,63	147,95	3,68	67,58	,6703
64	,90224	—	52,45	148,74	3,71	67,23	,6668
100 + 65	,90299	—	53,27	149,52	3,75	66,88	,6633
66	,90374	—	54,09	150,30	3,79	66,53	,6599
67	,90448	—	54,91	151,08	3,83	66,18	,6565
68	,90521	—	55,72	151,86	3,86	65,84	,6531
69	,90593	—	56,54	152,64	3,90	65,51	,6498
100 + 70	,90663	—	57,36	153,42	3,94	65,17	,6464
71	,90732	—	58,19	154,22	3,97	64,84	,6431
72	,90800	—	59,00	155,00	4,00	64,51	,6399
73	,90867	—	59,82	155,79	4,03	64,19	,6367
74	,90933	—	60,64	156,58	4,06	63,86	,6335
100 + 75	,90999	—	61,46	157,36	4,10	63,54	,6303
76	,91063	—	62,28	158,15	4,13	63,23	,6272
77	,91127	—	63,10	158,93	4,17	62,91	,6241
78	,91190	—	63,92	159,72	4,20	62,60	,6210
79	,91253	—	64,74	160,51	4,23	62,30	,6179
100 + 80	,91316	—	65,56	161,30	4,26	61,99	,6149
81	,91376	—	66,38	162,09	4,29	61,69	,6119
82	,91437	—	67,20	162,87	4,33	61,40	,6089
83	,91497	—	68,02	163,66	4,36	61,10	,6061
84	,91556	—	68,84	164,46	4,38	60,81	,6032
100 + 85	,91614	—	69,66	165,24	4,42	60,52	,6003
86	,91671	—	70,48	166,03	4,45	60,23	,5974
87	,91728	—	71,30	166,82	4,48	59,94	,5946
88	,91784	—	72,12	167,61	4,51	59,66	,5918
89	,91839	—	72,94	168,40	4,54	59,38	,5890
100 + 90	,91893	—	73,76	169,19	4,57	59,10	,5862
91	,91947	—	74,58	169,98	4,60	58,83	,5835
92	,92000	—	75,39	170,77	4,62	58,56	,5808
93	,92053	—	76,21	171,57	4,64	58,29	,5781
94	,92105	—	77,03	172,36	4,67	58,02	,5755
100 + 95	,92155	—	77,85	173,15	4,70	57,75	,5728
96	,92207	—	78,66	173,93	4,73	57,49	,5703
97	,92257	—	79,48	174,72	4,76	57,23	,5677
98	,92307	—	80,30	175,51	4,79	56,97	,5651
99	,92358	—	81,12	176,31	4,81	56,72	,5626

TABLE II. HEAT 74°.

I. Water and Spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,92407	100	81,95	177,11	4,84	56,46	,5600
99	,92457	—	82,78	177,91	4,87	56,20	,5575
98	,92507	—	83,63	178,73	4,90	55,94	,5549
97	,92557	—	84,50	179,56	4,94	55,68	,5524
96	,92607	—	85,38	180,41	4,97	55,42	,5598
100 + 95	,92656	—	86,27	181,27	5,00	55,16	,5471
94	,92706	—	87,18	182,16	5,02	54,89	,5445
93	,92756	—	88,12	183,08	5,04	54,62	,5418
92	,92806	—	89,08	184,00	5,08	54,34	,5390
91	,92856	—	90,06	184,96	5,10	54,06	,5362
100 + 90	,92907	—	91,06	185,94	5,12	53,78	,5334
89	,92959	—	92,08	186,92	5,16	53,49	,5306
88	,93012	—	93,13	187,95	5,18	53,20	,5277
87	,93065	—	94,20	188,99	5,21	52,91	,5248
86	,93119	—	95,29	190,05	5,24	52,62	,5219
100 + 85	,93173	—	96,41	191,14	5,27	52,32	,5189
84	,93229	—	97,57	192,26	5,31	52,02	,5159
83	,93285	—	98,74	193,41	5,33	51,71	,5129
82	,93341	—	99,94	194,58	5,36	51,39	,5098
81	,93397	—	101,18	195,78	5,40	51,08	,5067
100 + 80	,93455	—	102,44	197,01	5,43	50,76	,5035
79	,93509	—	103,74	198,27	5,47	50,43	,5003
78	,93566	—	105,07	199,58	5,49	50,10	,4970
77	,93622	—	106,44	200,91	5,53	49,77	,4937
76	,93679	—	107,84	202,28	5,56	49,44	,4903
100 + 75	,93735	—	109,28	203,70	5,58	49,09	,4869
74	,93794	—	110,75	205,14	5,61	48,75	,4835
73	,93852	—	112,26	206,62	5,64	48,40	,4801
72	,93911	—	113,82	208,15	5,67	48,04	,4766
71	,93970	—	115,43	209,72	5,71	47,68	,4730
100 + 70	,94031	—	117,08	211,34	5,74	47,32	,4693
69	,94091	—	118,77	213,00	5,77	46,95	,4656
68	,94153	—	120,51	214,72	5,79	46,57	,4619
67	,94215	—	122,31	216,49	5,82	46,19	,4582
66	,94278	—	124,17	218,30	5,87	45,81	,4544
100 + 65	,94341	—	126,08	220,17	5,91	45,42	,4505
64	,94404	—	128,05	222,11	5,94	45,02	,4466
63	,94468	—	130,08	224,11	5,97	44,62	,4426
62	,94532	—	132,18	226,18	6,00	44,21	,4385
61	,94597	—	134,35	228,31	6,04	43,80	,4344
100 + 60	,94661	—	136,59	230,51	6,08	43,38	,4303
59	,94727	—	138,90	232,79	6,11	42,95	,4261
58	,94794	—	141,30	235,15	6,15	42,52	,4218
57	,94860	—	143,77	237,60	6,17	42,08	,4175
56	,94927	—	146,35	240,14	6,21	41,64	,4131
100 + 55	,94993	—	149,00	242,76	6,24	41,19	,4086
54	,95060	—	151,74	245,48	6,26	40,73	,4041
53	,95126	—	154,59	248,32	6,27	40,27	,3995
52	,95193	—	157,57	251,26	6,31	39,80	,3948
51	,95260	—	160,69	254,34	6,35	39,32	,3900

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95327	100	163,91	257,52	6,39	38,83	,3852
49	,95396	—	167,25	260,83	6,42	38,34	,3802
48	,95465	—	170,74	264,29	6,45	37,83	,3753
47	,95533	—	174,37	267,91	6,46	37,32	,3703
46	,95602	—	178,16	271,67	6,49	36,81	,3651
100 + 45	,95671	—	182,12	275,60	6,52	36,28	,3599
44	,95740	—	186,26	279,72	6,54	35,75	,3546
43	,95810	—	190,59	284,04	6,55	35,20	,3492
42	,95879	—	195,14	288,56	6,58	34,65	,3438
41	,95949	—	199,90	293,30	6,60	34,09	,3382
100 + 40	,96018	—	204,89	298,28	6,61	33,52	,3325
39	,96089	—	210,14	303,51	6,63	32,95	,3268
38	,96159	—	215,67	309,04	6,63	32,36	,3210
37	,96230	—	221,50	314,86	6,64	31,76	,3150
36	,96301	—	227,65	321,00	6,65	31,15	,3090
100 + 35	,96372	—	234,16	327,50	6,66	30,53	,3029
34	,96444	—	241,05	334,39	6,66	29,90	,2966
33	,96515	—	248,35	341,71	6,64	29,26	,2903
32	,96588	—	256,11	349,49	6,62	28,61	,2838
31	,96661	—	264,38	357,75	6,63	27,95	,2773
100 + 30	,96734	—	273,18	366,56	6,62	27,28	,2706
29	,96808	—	282,61	376,00	6,61	26,60	,2638
28	,96883	—	292,70	386,13	6,57	25,90	,2569
27	,96958	—	303,54	397,00	6,54	25,19	,2499
26	,97033	—	315,21	408,70	6,51	24,47	,2427
100 + 25	,97110	—	327,83	421,32	6,51	23,74	,2354
24	,97188	—	341,48	435,01	6,47	22,99	,2280
23	,97268	—	356,33	449,89	6,44	22,23	,2205
22	,97350	—	372,53	466,13	6,40	21,45	,2128
21	,97432	—	390,27	483,91	6,36	20,66	,2049
100 + 20	,97515	—	409,79	503,48	6,31	19,86	,1970
19	,97601	—	431,35	525,10	6,25	19,04	,1889
18	,97688	—	455,32	549,13	6,19	18,21	,1806
17	,97777	—	482,10	575,97	6,13	17,36	,1722
16	,97868	—	512,23	606,18	6,05	16,50	,1636
100 + 15	,97960	—	546,38	640,41	5,97	15,62	,1549
14	,98056	—	585,41	679,54	5,87	14,72	,1460
13	,98157	—	630,44	724,66	5,78	13,80	,1369
12	,98256	—	682,97	777,29	5,68	12,86	,1276
11	,98360	—	745,07	839,49	5,58	11,91	,1181
100 + 10	,98469	—	819,57	914,08	5,49	10,94	,1085
9	,98582	—	910,63	1005,30	5,33	9,95	,0987
8	,98698	—	1024,46	1119,26	5,20	8,93	,0886
7	,98820	—	1171,86	1265,74	5,12	7,90	,0784
6	,99047	—	1365,95	1461,02	4,93	6,85	,0679
100 + 5	,99080	—	1639,15	1734,34	4,81	5,77	,0572
4	,99218	—	2048,93	2144,30	4,63	4,66	,0463
3	,99365	—	2731,91	2827,43	4,48	3,53	,0351
2	,99518	—	4097,87	4193,52	4,35	2,38	,0237
1	,99678	—	8195,74	8291,50	4,24	1,21	,0120

TABLE I. HEAT 75°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81780	100	—	100,00	—	100,00	,9913
1	,82010	—	0,82	100,72	0,10	99,29	,9842
2	,82235	—	1,64	101,44	0,20	98,58	,9772
3	,82455	—	2,46	102,16	0,30	97,89	,9703
4	,82669	—	3,28	102,88	0,40	97,21	,9635
100 + 5	,82878	—	4,10	103,61	0,49	96,52	,9567
6	,83082	—	4,91	104,34	0,57	95,84	,9500
7	,83281	—	5,73	105,07	0,66	95,17	,9434
8	,83476	—	6,55	105,81	0,74	94,51	,9368
9	,83666	—	7,37	106,54	0,83	93,86	,9303
100 + 10	,83851	—	8,19	107,28	0,91	93,21	,9239
11	,84031	—	9,01	108,03	0,98	92,57	,9176
12	,84206	—	9,83	108,77	1,06	91,94	,9113
13	,84378	—	10,65	109,52	1,13	91,31	,9051
14	,84546	—	11,47	110,27	1,20	90,69	,8990
100 + 15	,84710	—	12,29	111,02	1,27	90,07	,8930
16	,84872	—	13,11	111,77	1,34	89,47	,8870
17	,85031	—	13,93	112,52	1,41	88,87	,8810
18	,85188	—	14,75	113,28	1,47	88,28	,8751
19	,85342	—	15,56	114,03	1,53	87,69	,8693
100 + 20	,85496	—	16,38	114,79	1,59	87,12	,8636
21	,85642	—	17,20	115,54	1,66	86,55	,8579
22	,85788	—	18,02	116,30	1,72	85,99	,8523
23	,85932	—	18,84	117,05	1,79	85,43	,8468
24	,86073	—	19,66	117,81	1,85	84,88	,8414
100 + 25	,86212	—	20,48	118,57	1,91	84,34	,8360
26	,86347	—	21,30	119,33	1,97	83,80	,8306
27	,86480	—	22,12	120,10	2,02	83,27	,8253
28	,86610	—	22,94	120,86	2,08	82,74	,8201
29	,86738	—	23,76	121,62	2,14	82,22	,8150
100 + 30	,86864	—	24,58	122,39	2,19	81,71	,8099
31	,86988	—	25,39	123,16	2,23	81,20	,8049
32	,87110	—	26,21	123,92	2,29	80,70	,7999
33	,87231	—	27,03	124,69	2,34	80,20	,7950
34	,87350	—	27,85	125,46	2,39	79,71	,7901
100 + 35	,87466	—	28,67	126,22	2,45	79,22	,7853
36	,87580	—	29,49	126,99	2,50	78,74	,7806
37	,87692	—	30,31	127,76	2,55	78,27	,7759
38	,87802	—	31,13	128,53	2,60	77,80	,7712
39	,87911	—	31,95	129,31	2,64	77,34	,7666
100 + 40	,88018	—	32,77	130,08	2,69	76,88	,7621
41	,88125	—	33,59	130,85	2,74	76,42	,7576
42	,88230	—	34,41	131,62	2,79	75,98	,7531
43	,88334	—	35,22	132,39	2,83	75,54	,7487
44	,88437	—	36,04	133,16	2,88	75,10	,7444
100 + 45	,88538	—	36,86	133,93	2,93	74,67	,7401
46	,88637	—	37,68	134,70	2,98	74,24	,7359
47	,88734	—	38,50	135,48	3,02	73,81	,7317
48	,88830	—	39,32	136,25	3,07	73,39	,7275
49	,88925	—	40,14	137,03	3,11	72,98	,7234

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,89018	100	40,96	137,80	3,16	72,57	,7193
51	,89110	—	41,78	138,58	3,20	72,16	,7153
52	,89201	—	42,60	139,36	3,24	71,76	,7113
53	,89290	—	43,42	140,13	3,29	71,36	,7074
54	,89378	—	44,23	140,91	3,32	70,97	,7035
100 + 55	,89464	—	45,05	141,69	3,36	70,58	,6996
56	,89548	—	45,87	142,47	3,40	70,19	,6958
57	,89631	—	46,69	143,25	3,44	69,81	,6920
58	,89713	—	47,51	144,03	3,48	69,43	,6882
59	,89793	—	48,33	144,81	3,52	69,05	,6845
100 + 60	,89872	—	49,15	145,59	3,56	68,68	,6808
61	,89950	—	49,97	146,38	3,59	68,32	,6772
62	,90026	—	50,79	147,16	3,63	67,95	,6736
63	,90102	—	51,61	147,94	3,67	67,59	,6700
64	,90177	—	52,43	148,73	3,70	67,24	,6665
100 + 65	,90252	—	53,25	149,51	3,74	66,89	,6630
66	,90327	—	54,07	150,29	3,78	66,54	,6595
67	,90401	—	54,89	151,07	3,82	66,19	,6561
68	,90474	—	55,70	151,85	3,85	65,85	,6527
69	,90546	—	56,52	152,63	3,89	65,52	,6494
100 + 70	,90617	—	57,34	153,41	3,93	65,18	,6461
71	,90686	—	58,16	154,20	3,96	64,85	,6428
72	,90754	—	58,98	154,99	3,99	64,52	,6395
73	,90821	—	59,80	155,78	4,02	64,20	,6363
74	,90887	—	60,62	156,56	4,06	63,87	,6331
100 + 75	,90952	—	61,44	157,35	4,09	63,55	,6300
76	,91017	—	62,26	158,14	4,12	63,24	,6268
77	,91081	—	63,08	158,92	4,16	62,92	,6237
78	,91145	—	63,90	159,71	4,19	62,61	,6206
79	,91208	—	64,71	160,50	4,21	62,31	,6176
100 + 80	,91270	—	65,53	161,28	4,25	62,00	,6146
81	,91331	—	66,35	162,07	4,28	61,70	,6116
82	,91392	—	67,17	162,86	4,31	61,40	,6087
83	,91452	—	67,99	163,65	4,34	61,11	,6058
84	,91511	—	68,81	164,44	4,37	60,81	,6029
100 + 85	,91569	—	69,63	165,22	4,41	60,52	,6000
86	,91626	—	70,45	166,01	4,44	60,24	,5971
87	,91683	—	71,27	166,80	4,47	59,95	,5943
88	,91739	—	72,09	167,59	4,50	59,67	,5915
89	,91794	—	72,91	168,38	4,53	59,39	,5887
100 + 90	,91849	—	73,73	169,17	4,56	59,11	,5860
91	,91902	—	74,55	169,96	4,59	58,84	,5832
92	,91955	—	75,36	170,75	4,61	58,57	,5805
93	,92008	—	76,18	171,55	4,63	58,30	,5779
94	,92060	—	77,00	172,34	4,66	58,03	,5752
100 + 95	,92111	—	77,82	173,13	4,69	57,76	,5726
96	,92162	—	78,63	173,91	4,72	57,50	,5700
97	,92213	—	79,45	174,70	4,75	57,24	,5674
98	,92263	—	80,27	175,49	4,78	56,98	,5648
99	,92314	—	81,09	176,29	4,80	56,73	,5623

TABLE II. HEAT 75°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,92364	100	81,92	177,09	4,83	56,47	,5598	100 + 50	,95292	100	163,84	257,46	6,38	38,84	,3850
99	,92414	—	82,75	177,89	4,86	56,21	,5572	49	,95361	—	167,18	260,78	6,40	38,35	,3801
98	,92464	—	83,60	178,71	4 89	55,95	,5547	48	,95430	—	170,66	264,24	6,42	37,84	,3751
97	,92513	—	84,46	179,54	4,92	55,69	,5521	47	,95499	—	174,29	267,85	6,44	37,33	,3701
96	,92563	—	85,34	180,39	4,95	55,43	,5495	46	,95568	—	178,08	271,61	6,47	36,82	,3650
100 + 95	,92613	—	86,23	181,25	4,98	55,17	,5469	100 + 45	,95638	—	182,04	275,53	6,51	36,29	,3598
94	,92663	—	87,14	182,14	5,00	54,90	,5442	44	,95707	—	186,18	279,65	6,53	35,76	,3545
93	,92713	—	88,08	183,05	5,03	54,63	,5415	43	,95777	—	190,51	283,97	6,54	35,21	,3491
92	,92763	—	89,04	183,98	5,06	54,35	,5388	42	,95847	—	195,05	288,49	6,56	34,66	,3436
91	,92814	—	90,02	184,94	5,08	54,07	,5360	41	,95917	—	199,81	293,23	6,58	34,10	,3380
100 + 90	,92865	—	91,02	185,91	5,11	53,79	,5332	100 + 40	,95987	—	204,80	298,20	6,60	33,53	,3324
89	,92917	—	92,04	186,90	5,14	53,50	,5304	39	,96058	—	210,05	303,43	6,62	32,96	,3267
88	,92970	—	93,09	187,92	5,17	53,21	,5275	38	,96129	—	215,57	308,95	6,62	32,37	,3209
87	,93023	—	94,16	188,96	5,20	52,92	,5246	37	,96200	—	221,40	314,76	6,64	31,77	,3149
86	,93077	—	95,25	190,02	5,23	52,62	,5217	36	,96272	—	227,55	320,90	6,65	31,16	,3089
100 + 85	,93132	—	96,37	191,11	5,26	52,32	,5187	100 + 35	,96344	—	234,05	327,41	6,64	30,54	,3028
84	,93188	—	97,52	192,23	5,29	52,02	,5157	34	,96416	—	240,94	334,29	6,65	29,91	,2965
83	,93244	—	98,69	193,38	5,31	51,71	,5126	33	,96488	—	248,24	341,61	6,63	29,27	,2902
82	,93300	—	99,90	194,55	5,35	51,40	,5095	32	,96561	—	256,00	349,38	6,62	28,62	,2837
81	,93356	—	101,14	195,75	5,39	51,08	,5064	31	,96634	—	264,26	357,64	6,62	27,96	,2772
100 + 80	,93413	—	102,40	196,98	5,42	50,77	,5032	100 + 30	,96708	—	273,06	366,44	6,62	27,29	,2705
79	,93469	—	103,69	198,24	5,45	50,44	,5000	29	,96783	—	282,48	375,88	6,60	26,60	,2637
78	,93525	—	105,02	199,54	5,48	50,11	,4967	28	,96858	—	292,57	386,00	6,57	25,91	,2568
77	,93581	—	106,39	200,88	5,51	49,78	,4934	27	,96933	—	303,40	396,86	6,54	25,20	,2498
76	,93638	—	107,79	202,25	5,54	49,44	,4901	26	,97009	—	315,07	408,55	6,52	24,48	,2426
100 + 75	,93695	—	109,23	203,66	5,57	49,10	,4867	100 + 25	,97086	—	327,68	421,17	6,51	23,74	,2354
74	,93753	—	110,70	205,10	5,60	48,75	,4833	24	,97165	—	341,33	434,86	6,47	22,99	,2280
73	,93811	—	112,21	206,59	5,62	48,40	,4798	23	,97246	—	356,17	449,73	6,44	22,23	,2204
72	,93870	—	113,77	208,12	5,65	48,05	,4763	22	,97328	—	372,36	466,96	6,40	21,46	,2127
71	,93929	—	115,38	209,69	5,69	47,69	,4727	21	,97411	—	389,09	483,73	6,36	20,67	,2049
100 + 70	,93989	—	117,03	211,31	5,72	47,32	,4691	100 + 20	,97495	—	409,60	503,29	6,31	19,87	,1970
69	,94050	—	118,72	212,97	5,75	46,95	,4654	19	,97581	—	431,15	524,90	6,25	19,05	,1889
68	,94112	—	120,46	214,68	5,78	46,58	,4617	18	,97669	—	455,11	548,91	6,20	18,21	,1806
67	,94174	—	122,26	216,45	5,81	46,20	,4580	17	,97759	—	481,88	575,74	6,14	17,36	,1722
66	,94237	—	124,12	218,27	5,85	45,82	,4542	16	,97850	—	511,99	605,93	6,06	16,50	,1636
100 + 65	,94301	—	126,03	220,14	5,89	45,43	,4503	100 + 15	,97943	—	546,13	640,15	5,98	15,62	,1549
64	,94364	—	127,99	222,07	5,92	45,03	,4464	14	,98039	—	585,14	679,25	5,89	14,72	,1460
63	,94428	—	130,02	224,07	5,95	44,63	,4424	13	,98138	—	630,15	724,35	5,80	13,80	,1369
62	,94493	—	132,12	226,14	5,98	44,22	,4383	12	,98240	—	682,66	776,96	5,70	12,87	,1276
61	,94558	—	134,29	228,27	6,02	43,81	,4342	11	,98345	—	744,72	839,12	5,60	11,92	,1181
100 + 60	,94623	—	136,53	230,47	6,06	43,39	,4301	100 + 10	,98454	—	819,19	913,68	5,51	10,94	,1085
59	,94689	—	138,84	232,74	6,10	42,96	,4259	9	,98567	—	910,21	1004,85	5,36	9,95	,0987
58	,94756	—	141,23	235,10	6,13	42,53	,4216	8	,98684	—	1023,99	1118,76	5,23	8,94	,0886
57	,94823	—	143,71	237,55	6,16	42,09	,4173	7	,98806	—	1170,33	1265,17	5,16	7,90	,0784
56	,94890	—	146,28	240,09	6,19	41,65	,4129	6	,98933	—	1365,32	1460,36	4,96	6,85	,0679
100 + 55	,94957	—	148,93	242,71	6,22	41,20	,4084	100 + 5	,99066	—	1638,39	1733,55	4,84	5,77	,0572
54	,95023	—	151,67	245,43	6,24	40,74	,4039	4	,99205	—	2047,98	2143,32	4,66	4,66	,0462
53	,95090	—	154,52	248,26	6,26	40,28	,3993	3	,99351	—	2730,64	2826,13	4,51	3,53	,0351
52	,95157	—	157,50	251,21	6,29	39,81	,3946	2	,99504	—	4095,96	4191,58	4,38	2,38	,0237
51	,95224	—	160,61	254,28	6,33	39,33	,3898	1	,99664	—	8191,92	8287,65	4,27	1,21	,0120

TABLE I. HEAT 76°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81730	100	—	100,00	—	100,00	,9907
1	,81961	—	0,82	100,72	0,10	99,29	,9836
2	,82185	—	1,64	101,44	0,20	98,58	,9767
3	,82406	—	2,46	102,16	0,30	97,89	,9698
4	,82620	—	3,28	102,88	0,40	97,21	,9630
100 + 5	,82829	—	4,10	103,61	0,49	96,52	,9562
6	,83033	—	4,91	104,34	0,57	95,84	,9495
7	,83232	—	5,73	105,07	0,66	95,17	,9429
8	,83427	—	6,55	105,81	0,74	94,51	,9363
9	,83617	—	7,37	106,54	0,83	93,86	,9298
100 + 10	,83801	—	8,19	107,28	0,91	93,21	,9234
11	,83982	—	9,01	108,03	0,98	92,57	,9171
12	,84157	—	9,83	108,77	1,06	91,94	,9108
13	,84329	—	10,64	109,52	1,12	91,31	,9046
14	,84498	—	11,46	110,27	1,19	90,69	,8985
100 + 15	,84662	—	12,28	111,02	1,26	90,07	,8925
16	,84824	—	13,11	111,77	1,34	89,47	,8865
17	,84983	—	13,92	112,52	1,40	88,87	,8805
18	,85140	—	14,74	113,27	1,47	88,28	,8746
19	,85293	—	15,56	114,03	1,53	87,70	,8688
100 + 20	,85447	—	16,37	114,79	1,58	87,12	,8631
21	,85593	—	17,19	115,53	1,66	86,55	,8575
22	,85739	—	18,01	116,29	1,72	85,99	,8519
23	,85883	—	18,83	117,04	1,79	85,43	,8464
24	,86024	—	19,65	117,81	1,84	84,88	,8409
100 + 25	,86163	—	20,47	118,57	1,90	84,34	,8355
26	,86298	—	21,29	119,33	1,96	83,80	,8302
27	,86431	—	22,11	120,09	2,02	83,27	,8249
28	,86562	—	22,93	120,86	2,07	82,74	,8197
29	,86690	—	23,74	121,61	2,13	82,22	,8146
100 + 30	,86816	—	24,57	122,38	2,19	81,71	,8095
31	,86940	—	25,38	123,15	2,23	81,20	,8045
32	,87062	—	26,20	123,92	2,28	80,70	,7995
33	,87184	—	27,02	124,68	2,34	80,21	,7945
34	,87303	—	27,84	125,45	2,39	79,72	,7897
100 + 35	,87419	—	28,66	126,21	2,45	79,23	,7849
36	,87533	—	29,48	126,98	2,50	78,75	,7802
37	,87644	—	30,30	127,75	2,55	78,27	,7755
38	,87754	—	31,12	128,52	2,60	77,80	,7708
39	,87863	—	31,93	129,30	2,63	77,34	,7662
100 + 40	,87970	—	32,75	130,07	2,68	76,89	,7617
41	,88077	—	33,57	130,84	2,73	76,43	,7572
42	,88182	—	34,39	131,61	2,78	75,98	,7527
43	,88287	—	35,20	132,38	2,82	75,54	,7483
44	,88390	—	36,02	133,15	2,87	75,10	,7440
100 + 45	,88490	—	36,84	133,92	2,92	74,67	,7397
46	,88590	—	37,66	134,69	2,97	74,24	,7355
47	,88687	—	38,48	135,47	3,01	73,82	,7313
48	,88783	—	39,30	136,24	3,06	73,40	,7272
49	,88878	—	40,12	137,02	3,10	72,98	,7231

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,88970	100	40,94	137,79	3,15	72,57	,7190
51	,89063	—	41,76	138,57	3,19	72,17	,7150
52	,89154	—	42,58	139,34	3,24	71,77	,7110
53	,89243	—	43,39	140,12	3,27	71,37	,7071
54	,89331	—	44,21	140,90	3,31	70,98	,7032
100 + 55	,89417	—	45,03	141,67	3,36	70,59	,6993
56	,89501	—	45,85	142,45	3,40	70,20	,6955
57	,89584	—	46,66	143,23	3,43	69,82	,6917
58	,89666	—	47,48	144,01	3,47	69,44	,6879
59	,89747	—	48,30	144,79	3,51	69,06	,6842
100 + 60	,89826	—	49,12	145,57	3,55	68,69	,6805
61	,89904	—	49,94	146,36	3,58	68,33	,6769
62	,89980	—	50,76	147,14	3,62	67,96	,6733
63	,90056	—	51,58	147,92	3,66	67,60	,6697
64	,90131	—	52,40	148,71	3,69	67,24	,6662
100 + 65	,90205	—	53,22	149,49	3,73	66,89	,6627
66	,90281	—	54,04	150,27	3,77	66,54	,6592
67	,90355	—	54,86	151,05	3,81	66,20	,6558
68	,90428	—	55,67	151,83	3,84	65,86	,6524
69	,90500	—	56,49	152,61	3,88	65,52	,6491
100 + 70	,90570	—	57,31	153,39	3,92	65,19	,6458
71	,90640	—	58,13	154,19	3,94	64,86	,6425
72	,90708	—	58,95	154,97	3,98	64,53	,6392
73	,90775	—	59,77	155,76	4,01	64,20	,6360
74	,90841	—	60,59	156,54	4,05	63,88	,6328
100 + 75	,90907	—	61,41	157,33	4,08	63,56	,6297
76	,90972	—	62,23	158,12	4,11	63,25	,6265
77	,91036	—	63,05	158,90	4,15	62,93	,6234
78	,91100	—	63,87	159,69	4,18	62,62	,6203
79	,91163	—	64,68	160,48	4,20	62,31	,6173
100 + 80	,91226	—	65,50	161,26	4,24	62,01	,6143
81	,91286	—	66,32	162,05	4,27	61,71	,6113
82	,91347	—	67,14	162,84	4,30	61,41	,6084
83	,91407	—	67,96	163,63	4,33	61,12	,6055
84	,91466	—	68,77	164,42	4,35	60,82	,6026
100 + 85	,91524	—	69,59	165,21	4,38	60,53	,5997
86	,91581	—	70,41	165,99	4,42	60,24	,5968
87	,91638	—	71,24	166,78	4,46	59,96	,5940
88	,91694	—	72,05	167,57	4,48	59,68	,5912
89	,91749	—	72,87	168,36	4,51	59,40	,5884
100 + 90	,91804	—	73,69	169,15	4,54	59,12	,5857
91	,91857	—	74,51	169,94	4,57	58,84	,5830
92	,91911	—	75,32	170,73	4,59	58,57	,5803
93	,91964	—	76,14	171,52	4,62	58,30	,5776
94	,92016	—	76,97	172,32	4,65	58,03	,5749
100 + 95	,92067	—	77,78	173,11	4,67	57,77	,5723
96	,92118	—	78,59	173,88	4,71	57,51	,5698
97	,92169	—	79,41	174,67	4,74	57,25	,5672
98	,92219	—	80,23	175,46	4,77	56,99	,5646
99	,92270	—	81,05	176,26	4,79	56,73	,5621

TABLE II. HEAT 76°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.	I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.								W. + Sp.							
100 + 100	,92320	100	81,88	177,06	4,82	56,48	,5595	100 + 50	,95255	100	163,76	257,40	6,36	38,85	,3849
99	,92370	—	82,71	177,86	4,85	56,22	,5569	49	,95325	—	167,10	260,71	6,39	38,36	,3800
98	,92420	—	83,56	178,68	4,88	55,96	,5544	48	,95395	—	170,58	264,17	6,41	37,85	,3750
97	,92469	—	84,42	179,51	4,91	55,70	,5518	47	,95464	—	174,21	267,78	6,43	37,34	,3700
96	,92519	—	85,30	180,36	4,94	55,44	,5492	46	,95534	—	177,99	271,54	6,45	36,82	,3649
100 + 95	,92569	—	86,19	181,22	4,97	55,18	,5466	100 + 45	,95603	—	181,95	275,46	6,49	36,30	,3596
94	,92619	—	87,10	182,11	4,99	54,91	,5440	44	,95674	—	186,09	279,57	6,52	35,77	,3544
93	,92669	—	88,03	183,02	5,01	54,64	,5413	43	,95744	—	190,42	283,89	6,53	35,22	,3490
92	,92720	—	88,99	183,95	5,04	54,36	,5386	42	,95814	—	194,95	288,41	6,54	34,67	,3435
91	,92771	—	89,97	184,91	5,06	54,08	,5358	41	,95885	—	199,71	293,15	6,56	34,11	,3379
100 + 90	,92822	—	90,97	185,89	5,08	53,80	,5330	100 + 40	,95955	—	204,70	298,11	6,59	33,54	,3323
89	,92874	—	91,99	186,87	5,12	53,51	,5302	39	,96026	—	209,95	303,34	6,61	32,96	,3266
88	,92927	—	93,04	187,90	5,14	53,22	,5273	38	,96098	—	215,47	308,86	6,61	32,37	,3208
87	,92980	—	94,11	188,94	5,17	52,93	,5244	37	,96169	—	221,29	314,67	6,62	31,77	,3148
86	,93034	—	95,20	190,00	5,20	52,63	,5214	36	,96242	—	227,44	320,81	6,63	31,17	,3088
100 + 85	,93089	—	96,32	191,08	5,24	52,33	,5184	100 + 35	,96314	—	233,94	327,31	6,63	30,55	,3027
84	,93145	—	97,47	192,20	5,27	52,03	,5154	34	,96386	—	240,82	334,19	6,63	29,92	,2965
83	,93201	—	98,64	193,35	5,29	51,72	,5124	33	,96459	—	248,12	341,50	6,62	29,28	,2901
82	,93258	—	99,85	194,52	5,33	51,41	,5093	32	,96532	—	255,88	349,27	6,61	28,63	,2836
81	,93314	—	101,09	195,72	5,37	51,09	,5062	31	,96606	—	264,13	357,53	6,60	27,97	,2771
100 + 80	,93370	—	102,35	196,94	5,41	50,77	,5030	100 + 30	,96680	—	272,93	366,32	6,61	27,30	,2704
79	,93427	—	103,64	198,20	5,44	50,44	,4998	29	,96756	—	282,34	375,75	6,59	26,61	,2637
78	,93483	—	104,97	199,51	5,46	50,12	,4965	28	,96831	—	292,43	385,86	6,57	25,91	,2568
77	,93540	—	106,34	200,85	5,49	49,79	,4932	27	,96907	—	303,25	396,72	6,53	25,21	,2498
76	,93597	—	107,74	202,21	5,53	49,45	,4899	26	,96984	—	314,92	408,40	6,52	24,49	,2426
100 + 75	,93653	—	109,17	203,62	5,55	49,10	,4865	100 + 25	,97062	—	327,52	421,02	6,50	23,75	,2353
74	,93712	—	110,64	205,06	5,58	48,76	,4831	24	,97141	—	341,17	434,70	6,47	23,00	,2279
73	,93770	—	112,15	206,56	5,59	48,41	,4796	23	,97223	—	356,00	449,56	6,44	22,24	,2204
72	,93825	—	113,71	208,09	5,62	48,06	,4761	22	,97305	—	372,18	466,78	6,40	21,47	,2127
71	,93888	—	115,32	209,65	5,67	47,70	,4725	21	,97389	—	389,90	483,54	6,36	20,68	,2049
100 + 70	,93949	—	116,97	211,27	5,70	47,33	,4689	100 + 20	,97473	—	409,40	503,09	6,31	19,88	,1969
69	,94010	—	118,66	212,93	5,73	46,96	,4653	19	,97560	—	430,94	524,69	6,25	19,06	,1888
68	,94072	—	120,40	214,64	5,76	46,59	,4616	18	,97648	—	454,89	548,69	6,20	18,22	,1806
67	,94134	—	122,20	216,41	5,79	46,21	,4578	17	,97739	—	481,65	575,51	6,14	17,37	,1722
66	,94197	—	124,06	218,22	5,84	45,82	,4540	16	,97830	—	511,75	605,68	6,07	16,51	,1636
100 + 65	,94262	—	125,97	220,10	5,87	45,43	,4501	100 + 15	,97924	—	545,87	639,88	5,99	15,63	,1548
64	,94325	—	127,93	222,03	5,90	45,04	,4462	14	,98020	—	584,86	678,96	5,90	14,73	,1459
63	,94389	—	129,96	224,03	5,93	44,64	,4422	13	,98120	—	629,85	724,04	5,81	13,81	,1368
62	,94454	—	132,05	226,10	5,95	44,23	,4382	12	,98222	—	682,34	776,62	5,72	12,87	,1276
61	,94520	—	134,22	228,22	6,00	43,82	,4341	11	,98328	—	744,37	838,76	5,61	11,92	,1181
100 + 60	,94585	—	136,46	230,43	6,03	43,40	,4299	100 + 10	,98436	—	818,80	913,28	5,52	10,95	,1085
59	,94651	—	138,77	232,70	6,07	42,97	,4258	9	,98550	—	909,78	1004,40	5,38	9,96	,0986
58	,94718	—	141,16	235,06	6,10	42,54	,4215	8	,98668	—	1023,51	1118,26	5,25	8,94	,0886
57	,94785	—	143,64	237,50	6,14	42,10	,4172	7	,98791	—	1169,77	1264,60	5,17	7,91	,0783
56	,94852	—	146,21	240,03	6,18	41,66	,4128	6	,98918	—	1364,68	1459,69	4,99	6,85	,0679
100 + 55	,94920	—	148,86	242,65	6,21	41,21	,4083	100 + 5	,99051	—	1637,62	1732,75	4,87	5,77	,0572
54	,94986	—	151,59	245,37	6,22	40,75	,4038	4	,99191	—	2047,03	2142,33	4,70	4,67	,0462
53	,95053	—	154,44	248,20	6,24	40,29	,3992	3	,99337	—	2729,36	2824,82	4,54	3,54	,0351
52	,95121	—	157,43	251,15	6,28	39,82	,3945	2	,99490	—	4094,04	4189,62	4,42	2,39	,0236
51	,95188	—	160,53	254,23	6,30	39,33	,3897	1	,99650	-	8188,08	8283,78	4,30	1,21	,0120

TABLE I. HEAT 77°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81680	100	—	100,00	—	100,00	,9901
1	,81911	—	0,82	100,72	0,10	99,29	,9830
2	,82136	—	1,64	101,44	0,20	98,59	,9761
3	,82357	—	2,46	102,16	0,30	97,89	,9692
4	,82571	—	3,28	102,88	0,40	97,21	,9624
100 + 5	,82780	—	4,10	103,61	0,49	96,52	,9556
6	,82984	—	4,91	104,34	0,57	95,84	,9490
7	,83183	—	5,73	105,07	0,66	95,17	,9423
8	,83378	—	6,55	105,81	0,74	94,51	,9357
9	,83568	—	7,36	106,54	0,82	93,86	,9292
100 + 10	,83752	—	8,18	107,28	0,91	93,21	,9229
11	,83933	—	9,00	108,02	0,98	92,57	,9166
12	,84108	—	9,82	108,77	1,05	91,94	,9103
13	,84280	—	10,64	109,51	1,13	91,31	,9041
14	,84449	—	11,46	110,26	1,20	90,69	,8980
100 + 15	,84613	—	12,28	111,01	1,27	90,08	,8919
16	,84775	—	13,10	111,76	1,34	89,47	,8859
17	,84934	—	13,91	112,51	1,40	88,87	,8800
18	,85091	—	14,73	113,27	1,46	88,28	,8741
19	,85244	—	15,55	114,02	1,53	87,70	,8683
100 + 20	,85397	—	16,36	114,78	1,58	87,12	,8626
21	,85544	—	17,18	115,53	1,65	86,55	,8570
22	,85690	—	18,00	116,29	1,71	85,99	,8514
23	,85834	—	18,82	117,04	1,78	85,44	,8459
24	,85975	—	19,64	117,80	1,84	84,89	,8404
100 + 25	,86113	—	20,46	118,56	1,90	84,34	,8350
26	,86249	—	21,28	119,32	1,96	83,80	,8297
27	,86382	—	22,10	120,09	2,01	83,27	,8244
28	,86514	—	22,92	120,85	2,07	82,75	,8192
29	,86642	—	23,73	121,61	2,12	82,23	,8141
100 + 30	,86768	—	24,56	122,38	2,18	81,72	,8090
31	,86892	—	25,36	123,14	2,22	81,21	,8040
32	,87015	—	26,19	123,91	2,28	80,71	,7990
33	,87136	—	27,01	124,67	2,34	80,21	,7941
34	,87256	—	27,83	125,44	2,39	79,72	,7893
100 + 35	,87372	—	28,65	126,20	2,45	79,23	,7845
36	,87485	—	29,46	126,97	2,49	78,75	,7797
37	,87596	—	30,28	127,74	2,54	78,27	,7750
38	,87706	—	31,10	128,51	2,59	77,81	,7704
39	,87815	—	31,92	129,29	2,63	77,35	,7658
100 + 40	,87921	—	32,74	130,06	2,68	76,89	,7613
41	,88029	—	33,56	130,83	2,73	76,43	,7568
42	,88134	—	34,37	131,60	2,77	75,99	,7523
43	,88239	—	35,19	132,37	2,82	75,55	,7479
44	,88343	—	36,01	133,14	2,87	75,11	,7436
100 + 45	,88442	—	36,83	133,91	2,92	74,68	,7393
46	,88543	—	37,64	134,68	2,96	74,25	,7351
47	,88640	—	38,46	135,46	3,00	73,82	,7309
48	,88736	—	39,28	136,23	3,05	73,40	,7268
49	,88831	—	40,10	137,01	3,09	72,99	,7227

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,88922	100	40,92	137,78	3,14	72,58	,7186
51	,89017	—	41,74	138,56	3,18	72,17	,7146
52	,89106	—	42,56	139,33	3,23	71,77	,7106
53	,89195	—	43,37	140,11	3,26	71,37	,7067
54	,89283	—	44,19	140,89	3,30	70,98	,7028
100 + 55	,89369	—	45,01	141,66	3,35	70,59	,6989
56	,89453	—	45,83	142,44	3,39	70,21	,6951
57	,89536	—	46,64	143,22	3,42	69,82	,6913
58	,89619	—	47,46	144,00	3,46	69,44	,6875
59	,89700	—	48,28	144,78	3,50	69,06	,6838
100 + 60	,89780	—	49,10	145,56	3,54	68,69	,6801
61	,89858	—	49,92	146,35	3,57	68,33	,6766
62	,89934	—	50,74	147,13	3,61	67,96	,6730
63	,90010	—	51,56	147,91	3,65	67,60	,6694
64	,90085	—	52,38	148,69	3,69	67,25	,6659
100 + 65	,90159	—	53,19	149,48	3,71	66,90	,6623
66	,90235	—	54,02	150,26	3,76	66,55	,6589
67	,90309	—	54,84	151,04	3,80	66,20	,6555
68	,90382	—	55,65	151,81	3,84	65,86	,6521
69	,90454	—	56,47	152,60	3,87	65,53	,6488
100 + 70	,90523	—	57,28	153,38	3,90	65,19	,6454
71	,90594	—	58,11	154,17	3,94	64,86	,6422
72	,90662	—	58,92	154,96	3,96	64,53	,6389
73	,90729	—	59,74	155,75	3,99	64,20	,6357
74	,90795	—	60,56	156,53	4,03	63,88	,6325
100 + 75	,90862	—	61,38	157,31	4,07	63,57	,6293
76	,90926	—	62,20	158,11	4,09	63,25	,6262
77	,90990	—	63,02	158,89	4,13	62,93	,6231
78	,91054	—	63,84	159,67	4,17	62,62	,6200
79	,91117	—	64,65	160,46	4,19	62,32	,6170
100 + 80	,91181	—	65,47	161,24	4,23	62,02	,6140
81	,91241	—	66,29	162,04	4,25	61,71	,6110
82	,91301	—	67,11	162,82	4,29	61,41	,6081
83	,91361	—	67,92	163,61	4,31	61,13	,6052
84	,91420	—	68,74	164,40	4,34	60,83	,6023
100 + 85	,91478	—	69,56	165,19	4,37	60,54	,5994
86	,91536	—	70,38	165,98	4,40	60,25	,5965
87	,91593	—	71,20	166,76	4,44	59,97	,5937
88	,91649	—	72,02	167,55	4,47	59,68	,5909
89	,91704	—	72,84	168,34	4,50	59,40	,5881
100 + 90	,91758	—	73,66	169,13	4,53	59,13	,5854
91	,91812	—	74,48	169,92	4,56	58,85	,5827
92	,91866	—	75,29	170,71	4,58	58,58	,5800
93	,91920	—	76,11	171,50	4,61	58,31	,5773
94	,91972	—	76,93	172,29	4,64	58,04	,5747
100 + 95	,92023	—	77,75	173,08	4,67	57,77	,5720
96	,92074	—	78,56	173,86	4,70	57,51	,5695
97	,92125	—	79,37	174,65	4,72	57,26	,5669
98	,92175	—	80,20	175,44	4,76	57,00	,5643
99	,92226	—	81,01	176,23	4,78	56,74	,5618

TABLE II. HEAT 77°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 100	,92275	100	81,84	177,04	4,80	56,48	,5592
99	,92326	—	82,67	177,84	4,83	56,23	,5567
98	,92375	—	83,52	178,66	4 86	55,97	,5541
97	,92425	—	84,38	179,49	4,89	55,71	,5516
96	,92475	—	85,26	180,34	4,92	55,44	,5490
100 + 95	,92525	—	86,15	181,20	4,95	55,18	,5464
94	,92575	—	87,06	182,09	4,97	54,92	,5437
93	,92625	—	87,99	183,00	4,99	54,65	,5410
92	,92676	—	88,95	183,93	5,02	54,37	,5383
91	,92727	—	89,93	184,89	5,04	54,08	,5355
100 + 90	,92778	—	90,93	185,86	5,07	53,80	,5327
89	,92830	—	91,95	186,84	5,11	53,51	,5299
88	,92883	—	93,00	187,87	5,13	53,23	,5270
87	,92937	—	94,07	188,91	5,16	52,94	,5241
86	,92991	—	95,16	189,97	5,19	52,64	,5212
100 + 85	,93046	—	96,28	191,05	5,23	52,34	,5182
84	,93102	—	97,43	192,17	5,26	52,04	,5152
83	,93158	—	98,60	193,32	5,28	51,73	,5121
82	,93215	—	99,80	194,48	5,32	51,42	,5090
81	,93272	—	101,04	195,68	5,36	51,10	,5059
100 + 80	,93327	—	102,30	196,91	5,39	50,78	,5028
79	,93385	—	103,59	198,17	5,42	50,45	,4996
78	,93441	—	104,92	199,47	5,45	50,12	,4963
77	,93498	—	106,29	200,81	5,48	49,80	,4930
76	,93555	—	107,69	202,18	5,51	49,46	,4897
100 + 75	,93611	—	109,12	203,59	5,53	49,11	,4863
74	,93670	—	110,59	205,03	5,56	48,77	,4829
73	,93728	—	112,10	206,52	5,58	48,42	,4794
72	,93784	—	113,66	208,06	5,60	48,07	,4759
71	,93847	—	115,27	209,62	5,65	47,70	,4723
100 + 70	,93908	—	116,92	211,24	5,68	47,34	,4687
69	,93969	—	118,60	212,90	5,70	46,97	,4651
68	,94031	—	120,35	214,60	5,75	46,59	,4614
67	,94094	—	122,14	216,37	5,77	46,22	,4576
66	,94157	—	124,00	218,18	5,82	45,83	,4538
100 + 65	,94222	—	125,91	220,05	5,86	45,44	,4499
64	,94285	—	127,87	221,99	5,88	45,04	,4460
63	,94350	—	129,90	223,98	5,92	44,64	,4421
62	,94415	—	131,99	226,05	5,94	44,23	,4380
61	,94481	—	134,16	228,18	5,98	43,82	,4339
100 + 60	,94546	—	136,39	230,38	6,01	43,41	,4297
59	,94613	—	138,70	232,65	6,05	42,98	,4256
58	,94680	—	141,09	235 01	6,08	42,55	,4213
57	,94747	—	143,57	237,45	6,12	42,11	,4170
56	,94810	—	146,14	239,98	6,16	41,67	,4126
100 + 55	,94882	—	148,79	242,60	6,19	41,21	,4081
54	,94948	—	151,52	245,31	6,21	40,76	,4036
53	,95016	—	154,37	248,15	6,22	40,30	,3990
52	,95084	—	157,36	251,09	6,27	39,83	,3943
51	,95151	—	160,45	254,18	6,27	39,34	,3895

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95219	100	163,68	257,34	6,34	38,86	,3847
49	,95289	—	167,02	260,64	6,38	38,36	,3798
48	,95359	—	170,50	264,11	6,39	37,86	,3748
47	,95429	—	174,13	267,71	6,42	37,35	,3698
46	,95500	—	177,91	271,46	6,45	36,83	,3647
100 + 45	,95569	—	181,86	275,39	6,47	36,31	,3595
44	,95640	—	186,00	279,50	6,50	35,77	,3542
43	,95710	—	190,33	283,81	6,52	35,23	,3489
42	,95781	—	194,86	288,34	6,52	34,68	,3434
41	,95852	—	199,61	293,07	6,54	34,12	,3378
100 + 40	,95922	—	204,60	298,03	6,57	33,55	,3322
39	,95994	—	209,85	303,26	6,59	32,97	,3265
38	,96066	—	215,37	308,77	6,60	32,38	,3207
37	,96138	—	221,19	314,59	6,60	31,78	,3147
36	,96211	—	227,34	320,72	6,62	31,18	,3087
100 + 35	,96280	—	233,83	327,21	6,62	30,56	,3026
34	,96356	—	240,71	334,09	6,62	29,93	,2964
33	,96429	—	248,00	341,40	6,60	29,29	,2900
32	,96503	—	255,76	349,16	6,60	28,64	,2835
31	,96577	—	264,01	357,41	6,60	27,98	,2770
100 + 30	,96652	—	272,80	366,20	6,60	27,31	,2704
29	,96728	—	282,21	375,63	6,58	26,62	,2636
28	,96804	—	292,29	385,73	6,56	25,92	,2567
27	,96881	—	303,11	396,58	6,53	25,22	,2497
26	,96958	—	314,77	408,25	6,52	24,50	,2426
100 + 25	,97038	—	327,37	420,87	6,50	23,76	,2352
24	,97117	—	341,01	434,54	6,47	23,01	,2279
23	,97199	—	355,83	449,39	6,44	22,25	,2203
22	,97282	—	372,00	466,60	6,40	21,48	,2126
21	,97366	—	389,72	483,35	6,37	20,69	,2048
100 + 20	,97451	—	409,21	502,89	6,32	19,89	,1969
19	,97538	—	430,74	524,48	6,26	19,07	,1888
18	,97627	—	454,67	548,47	6,20	18,23	,1805
17	,97718	—	481,42	575,28	6,14	17,38	,1721
16	,97810	—	511,51	605,43	6,08	16,52	,1636
100 + 15	,97905	—	545,61	639,61	6,00	15,63	,1548
14	,98003	—	584,58	678,68	5,90	14,73	,1459
13	,98101	—	629,56	723,73	5,83	13,81	,1368
12	,98203	—	682,02	776,29	5,73	12,88	,1275
11	,98310	—	744,02	838,40	5,62	11,93	,1181
100 + 10	,98418	—	818,42	912,89	5,53	10,95	,1085
9	,98533	—	909,36	1003,96	5,40	9,96	,0986
8	,98651	—	1023,03	1117,76	5,27	8,95	,0886
7	,98775	—	1169,21	1264,03	5,18	7,91	,0783
6	,98902	—	1364,04	1459,02	5,02	6,85	,0679
100 + 5	,99036	—	1636,85	1731,95	4,90	5,77	,0572
4	,99176	—	2046,06	2141,34	4,72	4,67	,0462
3	,99323	—	2728,08	2823,50	4,58	3,54	,0351
2	,99476	—	4092,12	4187,66	4,46	2,39	,0236
1	,99636	—	8184,23	8279,90	4,33	1,21	,0120

TABLE I. HEAT 78°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81630	100	—	100,00	—	100,00	,9894
1	,81861	—	0,82	100,72	0,10	99,29	,9824
2	,82086	—	1,64	101,44	0,20	98,59	,9755
3	,82308	—	2,46	102,16	0,30	97,89	,9686
4	,82522	—	3,28	102,88	0,40	97,21	,9618
100 + 5	,82730	—	4,09	103,60	0,49	96,52	,9551
6	,82935	—	4,91	104,34	0,57	95,85	,9484
7	,83134	—	5,73	105,07	0,66	95,18	,9418
8	,83328	—	6,55	105,81	0,74	94,52	,9352
9	,83518	—	7,36	106,54	0,82	93,86	,9287
100 + 10	,83702	—	8,18	107,28	0,90	93,21	,9223
11	,83883	—	9,00	108,02	0,98	92,57	,9160
12	,84059	—	9,82	108,77	1,05	91,94	,9098
13	,84231	—	10,63	109,51	1,12	91,31	,9035
14	,84400	—	11,45	110,26	1,19	90,69	,8974
100 + 15	,84564	—	12,27	111,01	1,26	90,08	,8914
16	,84727	—	13,09	111,76	1,33	89,47	,8854
17	,84886	—	13,91	112,51	1,40	88,88	,8795
18	,85042	—	14,73	113,26	1,47	88,28	,8736
19	,85195	—	15,54	114,02	1,52	87,70	,8678
100 + 20	,85347	—	16,35	114,78	1,57	87,13	,8622
21	,85495	—	17,18	115,53	1,65	86,56	,8565
22	,85641	—	18,00	116,29	1,71	85,99	,8509
23	,85784	—	18,82	117,04	1,78	85,44	,8454
24	,85926	—	19,63	117,80	1,83	84,89	,8400
100 + 25	,86064	—	20,45	118,56	1,89	84,34	,8346
26	,86200	—	21,27	119,32	1,95	83,80	,8293
27	,86333	—	22,09	120,08	2,01	83,27	,8240
28	,86465	—	22,90	120,84	2,06	82,75	,8188
29	,86594	—	23,72	121,60	2,12	82,23	,8137
100 + 30	,86719	—	24,54	122,37	2,17	81,72	,8086
31	,86844	—	25,35	123,14	2,21	81,21	,8036
32	,86967	—	26,18	123,91	2,27	80,71	,7986
33	,87089	—	26,99	124,67	2,32	80,22	,7937
34	,87208	—	27,81	125,44	2,37	79,73	,7889
100 + 35	,87324	—	28,64	126,20	2,44	79,24	,7841
36	,87437	—	29,45	126,97	2,48	78,76	,7793
37	,87548	—	30,27	127,73	2,54	78,28	,7746
38	,87658	—	31,09	128,51	2,58	77,81	,7700
39	,87767	—	31,90	129,28	2,62	77,35	,7654
100 + 40	,87873	—	32,72	130,06	2,66	76,89	,7609
41	,87981	—	33,54	130,83	2,71	76,44	,7564
42	,88086	—	34,36	131,59	2,77	75,99	,7519
43	,88191	—	35,17	132,36	2,81	75,55	,7475
44	,88295	—	35,99	133,13	2,86	75,11	,7432
100 + 45	,88395	—	36,81	133,90	2,91	74,68	,7389
46	,88496	—	37,62	134,67	2,95	74,25	,7347
47	,88593	—	38,44	135,45	2,99	73,83	,7305
48	,88689	—	39,26	136,22	3,04	73,41	,7264
49	,88784	—	40,08	137,00	3,08	73,00	,7223

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,88875	100	40,90	137,77	3,13	72,59	,7182
51	,88969	—	41,72	138,55	3,17	72,18	,7142
52	,89059	—	42,54	139,32	3,22	71,78	,7102
53	,89148	—	43,35	140,10	3,25	71,38	,7063
54	,89235	—	44,17	140,88	3,29	70,99	,7024
100 + 55	,89321	—	44,99	141,65	3,34	70,60	,6985
56	,89406	—	45,81	142,43	3,38	70,21	,6947
57	,89489	—	46,62	143,21	3,41	69,83	,6909
58	,89572	—	47,44	143,99	3,45	69,45	,6872
59	,89653	—	48,26	144,77	3,49	69,07	,6835
100 + 60	,89733	—	49,08	145,55	3,53	68,70	,6798
61	,89811	—	49,89	146,33	3,56	68,34	,6762
62	,89888	—	50,71	147,11	3,60	67,97	,6726
63	,89964	—	51,53	147,89	3,64	67,61	,6690
64	,90039	—	52,35	148,68	3,67	67,26	,6655
100 + 65	,90113	—	53,16	149,46	3,70	66,91	,6620
66	,90188	—	53,99	150,24	3,75	66,56	,6586
67	,90262	—	54,81	151,02	3,79	66,21	,6552
68	,90336	—	55,62	151,80	3,82	65,87	,6518
69	,90407	—	56,44	152,58	3,86	65,54	,6484
100 + 70	,90477	—	57,26	153,36	3,90	65,20	,6451
71	,90547	—	58,08	154,16	3,92	64,87	,6419
72	,90615	—	58,89	154,94	3,95	64,54	,6386
73	,90683	—	59,71	155,73	3,98	64,22	,6354
74	,90749	—	60,53	156,51	4,02	63,89	,6322
100 + 75	,90816	—	61,35	157,29	4,06	63,57	,6290
76	,90880	—	62,17	158,09	4,08	63,26	,6259
77	,90945	—	62,99	158,87	4,12	62,94	,6228
78	,91008	—	63,81	159,65	4,16	62,63	,6197
79	,91071	—	64,62	160,44	4,18	62,33	,6167
100 + 80	,91136	—	65,44	161,22	4,22	62,02	,6137
81	,91195	—	66,26	162,02	4,24	61,72	,6107
82	,91255	—	67,08	162,81	4,27	61,43	,6078
83	,91315	—	67,89	163,59	4,30	61,13	,6049
84	,91374	—	68,71	164,38	4,33	60,83	,6020
100 + 85	,91432	—	69,53	165,17	4,36	60,54	,5991
86	,91490	—	70,35	165,96	4,39	60,26	,5962
87	,91547	—	71,17	166,74	4,43	59,98	,5934
88	,91603	—	71,98	167,53	4,45	59,69	,5906
89	,91659	—	72,80	168,32	4,48	59,41	,5878
100 + 90	,91713	—	73,62	169,11	4,51	59,13	,5851
91	,91767	—	74,44	169,90	4,54	58,86	,5824
92	,91821	—	75,25	170,69	4,56	58,59	,5797
93	,91875	—	76,08	171,48	4,60	58,32	,5770
94	,91928	—	76,90	172,27	4,63	58,05	,5744
100 + 95	,91979	—	77,71	173,06	4,65	57,78	,5717
96	,92030	—	78,52	173,83	4,69	57,52	,5692
97	,92081	—	79,33	174,63	4,70	57,26	,5666
98	,92131	—	80,16	175,42	4,74	57,00	,5641
99	,92182	—	80,97	176,20	4,77	56,75	,5616

TABLE II. HEAT 78°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,92230	100	81,80	177,01	4,79	56,49	,5590
99	,92281	—	82,63	177,81	4,82	56,23	,5564
98	,92331	—	83,48	178,63	4,85	55,97	,5539
97	,92381	—	84,34	179,46	4,88	55,71	,5513
96	,92431	—	85,22	180,31	4,91	55,45	,5488
100 + 95	,92481	—	86,11	181,17	4,94	55,19	,5461
94	,92531	—	87,02	182,07	4,95	54,93	,5434
93	,92581	—	87,95	182,97	4,98	54,65	,5407
92	,92632	—	88,91	183,90	5,01	54,37	,5380
91	,92683	—	89,89	184,86	5,03	54,09	,5352
100 + 90	,92734	—	90,89	185,84	5,05	53,81	,5324
89	,92786	—	91,91	186,81	5,10	53,52	,5296
88	,92840	—	92,95	187,84	5,11	53,24	,5267
87	,92894	—	94,02	188,88	5,14	52,95	,5238
86	,92948	—	95,11	189,94	5,17	52,65	,5209
100 + 85	,93003	—	96,23	191,03	5,20	52,35	,5179
84	,93059	—	97,38	192,14	5,24	52,05	,5149
83	,93115	—	98,55	193,28	5,27	51,74	,5119
82	,93172	—	99,75	194,45	5,30	51,42	,5088
81	,93229	—	101,00	195,65	5,35	51,11	,5057
100 + 80	,93285	—	102,25	196,87	5,38	50,79	,5025
79	,93343	—	103,54	198,13	5,41	50,46	,4994
78	,93399	—	104,87	199,44	5,43	50,13	,4961
77	,93456	—	106,24	200,78	5,46	49,81	,4928
76	,93513	—	107,64	202,14	5,50	49,47	,4895
100 + 75	,93570	—	109,07	203,55	5,52	49,12	,4861
74	,93629	—	110,54	205,00	5,54	48,78	,4827
73	,93687	—	112,05	206,48	5,57	48,43	,4792
72	,93743	—	113,61	208,02	5,59	48,08	,4757
71	,93806	—	115,21	209,58	5,63	47,71	,4721
100 + 70	,93867	—	116,86	211,20	5,66	47,35	,4685
69	,93928	—	118,54	212,86	5,68	46,98	,4649
68	,93991	—	120,29	214,56	5,73	46,60	,4612
67	,94054	—	122,08	216,33	5,75	46,23	,4574
66	,94117	—	123,94	218,14	5,80	45,84	,4536
100 + 65	,94182	—	125,85	220,01	5,84	45,45	,4497
64	,94246	—	127,81	221,95	5,86	45,05	,4458
63	,94311	—	129,84	223,94	5,90	44,65	,4419
62	,94376	—	131,93	226,00	5,93	44,24	,4378
61	,94442	—	134,10	228,13	5,97	43,83	,4337
100 + 60	,94508	—	136,33	230,33	6,00	43,42	,4296
59	,94575	—	138,64	232,60	6,04	42,99	,4254
58	,94642	—	141,02	234,96	6,06	42,56	,4211
57	,94709	—	143,50	237,40	6,10	42,12	,4168
56	,94776	—	146,07	239,93	6,14	41,68	,4124
100 + 55	,94844	—	148,72	242,55	6,17	41,22	,4079
54	,94911	—	151,45	245,26	6,19	40,77	,4034
53	,94979	—	154,30	248,09	6,21	40,31	,3988
52	,95047	—	157,28	251,04	6,24	39,83	,3941
51	,95115	—	160,38	254,13	6,25	39,35	,3894

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95183	100	163,60	257,28	6,32	38,87	,3846
49	,95253	—	166,94	260,58	6,36	38,37	,3797
48	,95323	—	170,42	264,04	6,38	37,87	,3747
47	,95394	—	174,05	267,64	6,41	37,36	,3697
46	,95465	—	177,83	271,39	6,44	36,84	,3646
100 + 45	,95535	—	181,78	275,32	6,46	36,32	,3594
44	,95606	—	185,91	279,43	6,48	35,78	,3541
43	,95677	—	190,24	283,74	6,50	35,24	,3488
42	,95748	—	194,77	288,26	6,51	34,69	,3433
41	,95819	—	199,52	292,99	6,53	34,13	,3377
100 + 40	,95890	—	204,51	297,95	6,56	33,56	,3321
39	,95962	—	209,75	303,18	6,57	32,98	,3264
38	,96034	—	215,27	308,69	6,58	32,39	,3206
37	,96107	—	221,08	314,50	6,58	31,79	,3146
36	,96180	—	227,23	320,64	6,59	31,19	,3086
100 + 35	,96250	—	233,72	327,11	6,61	30,57	,3025
34	,96326	—	240,59	333,99	6,60	29,94	,2963
33	,96400	—	247,89	341,30	6,59	29,30	,2900
32	,96474	—	255,64	349,05	6,59	28,65	,2835
31	,96549	—	263,88	357,30	6,58	27,99	,2770
100 + 30	,96624	—	272,67	366,08	6,59	27,32	,2703
29	,96700	—	282,08	375,50	6,58	26,63	,2635
28	,96777	—	292,15	385,60	6,55	25,93	,2566
27	,96855	—	302,97	396,44	6,53	25,23	,2496
26	,96933	—	314,62	408,10	6,52	24,50	,2425
100 + 25	,97013	—	327,21	420,72	6,49	23,77	,2352
24	,97093	—	340,85	434,38	6,47	23,02	,2278
23	,97175	—	355,66	449,22	6,44	22,26	,2203
22	,97259	—	371,83	466,43	6,40	21,49	,2126
21	,97343	—	389,54	483,17	6,37	20,69	,2048
100 + 20	,97429	—	409,02	502,70	6,32	19,89	,1968
19	,97516	—	430,54	524,27	6,27	19,07	,1887
18	,97606	—	454,46	548,26	6,20	18,23	,1805
17	,97697	—	481,20	575,05	6,15	17,39	,1721
16	,97790	—	511,27	605,18	6,09	16,53	,1635
100 + 15	,97885	—	545,35	639,35	6,00	15,64	,1548
14	,97983	—	584,30	678,40	5,90	14,74	,1459
13	,98082	—	629,26	723,42	5,84	13,82	,1368
12	,98185	—	681,70	775,96	5,74	12,88	,1275
11	,98292	—	743,67	838,04	5,63	11,93	,1181
100 + 10	,98401	—	818,03	912,49	5,54	10,96	,1084
9	,98516	—	908,93	1003,52	5,41	9,97	,0986
8	,98635	—	1022,55	1117,26	5,29	8,95	,0886
7	,98759	—	1168,65	1263,46	5,19	7,91	,0783
6	,98887	—	1363,40	1458,35	5,05	6,86	,0678
100 + 5	,99021	—	1636,08	1731,16	4,92	5,78	,0572
4	,99161	—	2045,10	2140,35	4,75	4,67	,0462
3	,99308	—	2727,80	2822,19	4,61	3,54	,0351
2	,99462	—	4090,20	4185,70	4,50	2,39	,0236
1	,99622	—	8180,39	8276,03	4,36	1,21	,0120

TABLE I.

HEAT 79°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81580	100	—	100,00	—	100,00	,9888
1	,81811	—	0,82	100,71	0,11	99,29	,9818
2	,82037	—	1,63	101,43	0,20	98,59	,9749
3	,82258	—	2,45	102,15	0,30	97,89	,9680
4	,82472	—	3,27	102,87	0,40	97,21	,9612
100 + 5	,82681	—	4,09	103,60	0,49	96,52	,9545
6	,82885	—	4,90	104,33	0,57	95,85	,9478
7	,83084	—	5,72	105,06	0,66	95,18	,9412
8	,83278	—	6,54	105,80	0,74	94,52	,9346
9	,83468	—	7,35	106,53	0,82	93,86	,9281
100 + 10	,83652	—	8,18	107,27	0,91	93,22	,9218
11	,83833	—	9,00	108,02	0,98	92,58	,9155
12	,84010	—	9,81	108,76	1,05	91,95	,9093
13	,84182	—	10,63	109,50	1,13	91,32	,9030
14	,84351	—	11,45	110,26	1,19	90,70	,8969
100 + 15	,84516	—	12,27	111,01	1,26	90,09	,8908
16	,84678	—	13,09	111,76	1,33	89,48	,8848
17	,84837	—	13,90	112,51	1,39	88,88	,8790
18	,84993	—	14,72	113,26	1,46	88,29	,8731
19	,85146	—	15,54	114,02	1,52	87,70	,8673
100 + 20	,85298	—	16,35	114,78	1,57	87,13	,8617
21	,85446	—	17,17	115,52	1,65	86,56	,8560
22	,85592	—	17,99	116,28	1,71	86,00	,8504
23	,85735	—	18,81	117,03	1,78	85,45	,8449
24	,85877	—	19,62	117,79	1,83	84,90	,8395
100 + 25	,86015	—	20,44	118,55	1,89	84,35	,8341
26	,86151	—	21,26	119,31	1,95	83,81	,8288
27	,86284	—	22,08	120,08	2,00	83,28	,8235
28	,86416	—	22,89	120,84	2,05	82,76	,8183
29	,86545	—	23,71	121,60	2,11	82,24	,8132
100 + 30	,86670	—	24,53	122,37	2,16	81,73	,8081
31	,86796	—	25,34	123,13	2,21	81,22	,8031
32	,86920	—	26,16	123,90	2,26	80,72	,7982
33	,87041	—	26,98	124,66	2,32	80,22	,7932
34	,87160	—	27,80	125,43	2,37	79,73	,7884
100 + 35	,87276	—	28,62	126,19	2,43	79,24	,7836
36	,87389	—	29,43	126,96	2,47	78,76	,7789
37	,87500	—	30,25	127,73	2,52	78,28	,7742
38	,87610	—	31,07	128,50	2,57	77,82	,7696
39	,87719	—	31,89	129,27	2,62	77,36	,7650
100 + 40	,87824	—	32,71	130,05	2,66	76,90	,7605
41	,87933	—	33,53	130,82	2,71	76,44	,7560
42	,88038	—	34,34	131,58	2,76	76,00	,7515
43	,88143	—	35,16	132,35	2,81	75,56	,7471
44	,88247	—	35,97	133,12	2,85	75,12	,7428
100 + 45	,88348	—	36,80	133,89	2,91	74,69	,7385
46	,88448	—	37,60	134,66	2,94	74,26	,7343
47	,88546	—	38,42	135,44	2,98	73,83	,7301
48	,88642	—	39,24	136,21	3,03	73,41	,7260
49	,88736	—	40,06	136,99	3,07	73,00	,7219

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,88829	100	40,88	137,76	3,12	72,59	,7178
51	,88921	—	41,70	138,54	3,16	72,18	,7138
52	,89011	—	42,52	139,31	3,21	71,78	,7098
53	,89100	—	43,33	140,09	3,24	71,39	,7059
54	,89187	—	44,15	140,87	3,28	71,00	,7020
100 + 55	,89273	—	44,97	141,64	3,33	70,60	,6981
56	,89358	—	45,79	142,42	3,37	70,21	,6943
57	,89442	—	46,60	143,20	3,40	69,83	,6905
58	,89525	—	47,42	143,98	3,44	69,45	,6868
59	,89606	—	48,24	144,76	3,48	69,07	,6831
100 + 60	,89686	—	49,06	145,54	3,52	68,70	,6794
61	,89765	—	49,87	146,32	3,55	68,34	,6759
62	,89842	—	50,69	147,10	3,59	67,97	,6723
63	,89918	—	51,51	147,88	3,63	67,61	,6687
64	,89993	—	52,32	148,66	3,66	67,26	,6651
100 + 65	,90067	—	53,14	149,45	3,69	66,91	,6617
66	,90142	—	53,96	150,23	3,73	66,56	,6583
67	,90216	—	54,78	151,01	3,77	66,21	,6549
68	,90289	—	55,59	151,79	3,80	65,87	,6515
69	,90361	—	56,41	152,57	3,84	65,54	,6482
100 + 70	,90431	—	57,23	153,35	3,88	65,21	,6448
71	,90501	—	58,05	154,15	3,90	64,87	,6416
72	,90569	—	58,86	154,92	3,94	64,54	,6383
73	,90637	—	59,68	155,71	3,97	64,22	,6351
74	,90703	—	60,50	156,49	4,01	63,90	,6319
100 + 75	,90770	—	61,32	157,28	4,04	63,58	,6287
76	,90834	—	62,14	158,07	4,07	63,26	,6256
77	,90899	—	62,96	158,85	4,11	62,95	,6225
78	,90963	—	63,78	159,63	4,15	62,64	,6194
79	,91026	—	64,59	160,42	4,17	62,33	,6164
100 + 80	,91091	—	65,41	161,20	4,21	62,03	,6134
81	,91149	—	66,23	162,00	4,23	61,73	,6104
82	,91209	—	67,05	162,79	4,26	61,43	,6075
83	,91269	—	67,86	163,57	4,29	61,14	,6046
84	,91328	—	68,68	164,36	4,32	60,84	,6017
100 + 85	,91386	—	69,50	165,15	4,35	60,55	,5988
86	,91444	—	70,31	165,94	4,37	60,26	,5959
87	,91501	—	71,13	166,72	4,41	59,98	,5931
88	,91557	—	71,95	167,51	4,44	59,69	,5903
89	,91613	—	72,77	168,30	4,47	59,41	,5875
100 + 90	,91668	—	73,59	169,09	4,50	59,14	,5848
91	,91722	—	74,40	169,88	4,52	58,86	,5821
92	,91776	—	75,22	170,67	4,55	58,59	,5794
93	,91830	—	76,04	171,46	4,58	58,32	,5767
94	,91883	—	76,86	172,24	4,62	58,05	,5741
100 + 95	,91935	—	77,68	173,03	4,65	57,79	,5715
96	,91986	—	78,48	173,81	4,67	57,53	,5689
97	,92037	—	79,29	174,61	4,68	57,27	,5663
98	,92087	—	80,12	175,40	4,72	57,01	,5638
99	,92138	—	80,93	176,18	4,75	56,75	,5613

TABLE II. HEAT 79°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,92186	100	81,76	176,98	4,78	56,50	,5587
99	,92237	—	82,59	177,79	4,80	56,24	,5562
98	,92286	—	83,44	178,61	4,83	55,98	,5536
97	,92337	—	84,30	179,44	4,86	55,72	,5511
96	,92387	—	85,18	180,29	4,89	55,46	,5485
100 + 95	,92437	—	86,07	181,15	4,92	55,20	,5459
94	,92487	—	86,98	182,04	4,94	54,93	,5432
93	,92537	—	87,91	182,95	4,96	54,66	,5405
92	,92588	—	88,87	183,88	4,99	54,38	,5378
91	,92639	—	89,85	184,84	5,01	54,10	,5350
100 + 90	,92690	—	90,85	185,81	5,04	53,82	,5322
89	,92743	—	91,87	186,79	5,08	53,53	,5294
88	,92797	—	92,91	187,81	5,10	53,25	,5265
87	,92851	—	93,98	188,85	5,13	52,95	,5236
86	,92905	—	95,07	189,91	5,16	52,65	,5207
100 + 85	,92960	—	96,19	191,00	5,19	52,35	,5177
84	,93016	—	97,33	192,11	5,22	52,05	,5147
83	,93072	—	98,50	193,25	5,25	51,75	,5117
82	,93129	—	99,70	194,42	5,28	51,43	,5086
81	,93187	—	100,95	195,62	5,33	51,12	,5055
100 + 80	,93243	—	102,20	196,84	5,36	50,80	,5023
79	,93301	—	103,49	198,10	5,39	50,47	,4992
78	,93357	—	104,82	199,40	5,42	50,14	,4959
77	,93414	—	106,19	200,74	5,45	49,81	,4926
76	,93472	—	107,59	202,11	5,48	49,47	,4893
100 + 75	,93529	—	109,02	203,51	5,51	49,13	,4859
74	,93588	—	110,49	204,96	5,53	48,79	,4825
73	,93646	—	112,00	206,45	5,55	48,44	,4790
72	,93702	—	113,55	207,98	5,57	48,08	,4755
71	,93765	—	115,15	209,54	5,61	47,72	,4719
100 + 70	,93826	—	116,80	211,16	5,64	47,36	,4683
69	,93888	—	118,49	212,82	5,67	46,99	,4647
68	,93951	—	120,23	214,52	5,71	46,61	,4610
67	,94014	—	122,02	216,29	5,73	46,23	,4572
66	,94077	—	123,88	218,10	5,78	45,85	,4534
100 + 65	,94142	—	125,79	219,97	5,82	45,46	,4495
64	,94207	—	127,75	221,91	5,84	45,06	,4456
63	,94272	—	129,78	223,90	5,88	44,66	,4417
62	,94337	—	131,87	225,96	5,91	44,25	,4376
61	,94403	—	134,04	228,09	5,95	43,84	,4336
100 + 60	,94469	—	136,27	230,28	5,99	43,43	,4294
59	,94537	—	138,57	232,55	6,02	43,00	,4252
58	,94604	—	140,95	234,91	6,04	42,57	,4209
57	,94671	—	143,43	237,35	6,08	42,13	,4166
56	,94738	—	146,00	239,88	6,12	41,69	,4122
100 + 55	,94806	—	148,65	242,50	6,15	41,23	,4078
54	,94874	—	151,38	245,21	6,17	40,78	,4033
53	,94942	—	154,23	248,04	6,19	40,32	,3987
52	,95010	—	157,21	250,98	6,23	39,84	,3940
51	,95079	—	160,31	254,06	6,25	39,36	,3893

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95147	100	163,52	257,22	6,30	38,88	,3845
49	,95217	—	166,86	260,52	6,34	38,38	,3796
48	,95288	—	170,34	263,97	6,37	37,88	,3746
47	,95359	—	173,97	267,57	6,40	37,37	,3696
46	,95430	—	177,74	271,32	6,42	36,85	,3645
100 + 45	,95501	—	181,69	275,25	6,44	36,33	,3593
44	,95572	—	185,82	279,36	6,46	35,79	,3540
43	,95644	—	190,15	283,67	6,48	35,25	,3487
42	,95715	—	194,68	288,19	6,49	34,70	,3432
41	,95787	—	199,43	292,91	6,52	34,14	,3376
100 + 40	,95858	—	204,41	297,87	6,54	33,57	,3320
39	,95930	—	209,65	303,10	6,55	32,99	,3263
38	,96003	—	215,17	308,60	6,57	32,40	,3205
37	,96076	—	220,98	314,42	6,56	31,80	,3145
36	,96149	—	227,13	320,56	6,57	31,20	,3085
100 + 35	,96220	—	233,61	327,01	6,60	30,58	,3024
34	,96296	—	240,48	333,89	6,59	29,95	,2962
33	,96371	—	247,77	341,20	6,57	29,31	,2899
32	,96445	—	255,52	348,94	6,58	28,66	,2834
31	,96521	—	263,76	357,18	6,58	28,00	,2769
100 + 30	,96596	—	272,54	365,96	6,58	27,33	,2702
29	,96673	—	281,95	375,38	6,57	26,64	,2635
28	,96750	—	292,01	385,47	6,54	25,94	,2566
27	,96829	—	302,83	396,30	6,53	25,23	,2496
26	,96908	—	314,47	407,95	6,52	24,51	,2424
100 + 25	,96988	—	327,06	420,57	6,49	23,78	,2351
24	,97069	—	340,69	434,22	6,47	23,03	,2278
23	,97151	—	355,49	449,06	6,43	22,27	,2203
22	,97236	—	371,66	466,26	6,40	21,49	,2125
21	,97321	—	389,36	482,99	6,37	20,70	,2047
100 + 20	,97407	—	408,83	502,51	6,32	19,90	,1968
19	,97494	—	430,34	524,07	6,27	19,08	,1887
18	,97585	—	454,25	548,04	6,21	18,24	,1804
17	,97676	—	480,97	574,82	6,15	17,39	,1720
16	,97770	—	511,03	604,94	6,09	16,53	,1635
100 + 15	,97865	—	545,10	639,09	6,01	15,65	,1547
14	,97963	—	584,03	678,12	5,91	14,75	,1458
13	,98063	—	628,97	723,12	5,85	13,83	,1367
12	,98167	—	681,38	775,63	5,75	12,89	,1275
11	,98274	—	743,32	837,68	5,64	11,94	,1180
100 + 10	,98384	—	817,65	912,10	5,55	10,96	,1084
9	,98499	—	908,51	1003,08	5,43	9,97	,0986
8	,98619	—	1022,07	1116,76	5,31	8,95	,0886
7	,98743	—	1168,09	1262,89	5,20	7,92	,0783
6	,98872	—	1362,76	1457,69	5,07	6,86	,0678
100 + 5	,99006	—	1635,31	1730,37	4,94	5,78	,0571
4	,99146	—	2044,14	2139,35	4,79	4,67	,0462
3	,99293	—	2725,51	2820,86	4,65	3,54	,0351
2	,99447	—	4088,27	4183,74	4,53	2,39	,0236
1	,99607	—	8176,55	8272,15	4,40	1,21	,0120

TABLE I. HEAT 80°.

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 0	,81530	100	—	100,00	—	100,00	,9882
1	,81761	—	0,82	100,71	0,11	99,29	,9812
2	,81987	—	1,63	101,43	0,20	98,59	,9743
3	,82207	—	2,45	102,15	0,30	97,89	,9674
4	,82422	—	3,27	102,87	0,40	97,21	,9606
100 + 5	,82631	—	4,09	103,60	0,49	96,52	,9539
6	,82835	—	4,90	104,33	0,57	95,85	,9472
7	,83034	—	5,72	105,06	0,66	95,18	,9406
8	,83228	—	6,54	105,80	0,74	94,52	,9340
9	,83418	—	7,35	106,53	0,82	93,86	,9275
100 + 10	,83603	—	8,17	107,27	0,90	93,22	,9212
11	,83783	—	8,99	108,01	0,98	92,58	,9149
12	,83960	—	9,81	108,76	1,05	91,95	,9087
13	,84133	—	10,62	109,50	1,12	91,32	,9025
14	,84302	—	11,44	110,25	1,19	90,70	,8964
100 + 15	,84467	—	12,26	111,00	1,26	90,09	,8903
16	,84629	—	13,08	111,75	1,33	89,48	,8843
17	,84788	—	13,89	112,50	1,39	88,88	,8784
18	,84944	—	14,71	113,26	1,45	88,29	,8726
19	,85097	—	15,53	114,01	1,52	87,71	,8668
100 + 20	,85248	—	16,34	114,77	1,57	87,13	,8611
21	,85397	—	17,16	115,52	1,64	86,56	,8555
22	,85543	—	17,98	116,28	1,70	86,00	,8499
23	,85686	—	18,80	117,03	1,77	85,45	,8444
24	,85827	—	19,61	117,79	1,82	84,90	,8390
100 + 25	,85966	—	20,43	118,55	1,88	84,35	,8336
26	,86102	—	21,25	119,31	1,94	83,81	,8283
27	,86235	—	22,07	120,07	2,00	83,28	,8231
28	,86367	—	22,88	120,83	2,05	82,76	,8179
29	,86496	—	23,70	121,59	2,11	82,24	,8128
100 + 30	,86622	—	24,52	122,36	2,16	81,73	,8077
31	,86748	—	25,33	123,12	2,21	81,22	,8027
32	,86872	—	26,15	123,89	2,26	80,72	,7977
33	,86993	—	26,97	124,65	2,32	80,23	,7928
34	,87112	—	27,79	125,42	2,37	79,74	,7880
100 + 35	,87228	—	28,60	126,18	2,42	79,25	,7832
36	,87341	—	29,42	126,95	2,47	78,77	,7784
37	,87452	—	30,24	127,72	2,52	78,29	,7737
38	,87562	—	31,06	128,49	2,57	77,82	,7691
39	,87670	—	31,87	129,26	2,61	77,36	,7645
100 + 40	,87776	—	32,69	130,04	2,65	76,90	,7600
41	,87884	—	33,51	130,81	2,70	76,45	,7555
42	,87990	—	34,32	131,57	2,75	76,00	,7511
43	,88095	—	35,14	132,34	2,80	75,56	,7467
44	,88199	—	35,96	133,11	2,85	75,12	,7424
100 + 45	,88301	—	36,78	133,88	2,90	74,69	,7381
46	,88400	—	37,59	134,65	2,94	74,26	,7339
47	,88498	—	38,41	135,43	2,98	73,84	,7297
48	,88594	—	39,23	136,20	3,03	73,42	,7256
49	,88688	—	40,04	136,98	3,06	73,01	,7215

I. Spirit and water by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
Sp. + W.							
100 + 50	,88781	100	40,86	137,75	3,11	72,60	,7174
51	,88873	—	41,68	138,53	3,15	72,19	,7134
52	,88963	—	42,50	139,30	3,20	71,79	,7094
53	,89052	—	43,31	140,08	3,23	71,40	,7055
54	,89139	—	44,13	140,86	3,27	71,01	,7016
100 + 55	,89225	—	44,95	141,63	3,32	70,61	,6977
56	,89310	—	45,77	142,41	3,36	70,22	,6939
57	,89394	—	46,58	143,19	3,39	69,84	,6901
58	,89477	—	47,40	143,97	3,43	69,46	,6864
59	,89559	—	48,22	144,75	3,47	69,08	,6827
100 + 60	,89639	—	49,04	145,53	3,51	68,71	,6791
61	,89718	—	49,85	146,31	3,54	68,35	,6755
62	,89795	—	50,67	147,09	3,58	67,98	,6719
63	,89871	—	51,49	147,87	3,62	67,62	,6683
64	,89947	—	52,30	148,65	3,65	67,27	,6648
100 + 65	,90021	—	53,12	149,44	3,68	66,92	,6613
66	,90095	—	53,94	150,22	3,72	66,57	,6579
67	,90169	—	54,76	151,00	3,76	66,22	,6545
68	,90242	—	55,57	151,78	3,79	65,88	,6511
69	,90314	—	56,39	152,56	3,83	65,55	,6478
100 + 70	,90385	—	57,21	153,34	3,87	65,21	,6445
71	,90454	—	58,03	154,13	3,90	64,88	,6412
72	,90522	—	58,84	154,91	3,93	64,55	,6379
73	,90590	—	59,66	155,70	3,96	64,23	,6347
74	,90657	—	60,48	156,48	4,00	63,91	,6315
100 + 75	,90723	—	61,29	157,27	4,02	63,59	,6284
76	,90788	—	62,11	158,05	4,06	63,27	,6253
77	,90853	—	62,93	158,84	4,09	62,96	,6222
78	,90917	—	63,75	159,62	4,13	62,65	,6191
79	,90980	—	64,56	160,41	4,15	62,34	,6161
100 + 80	,91046	—	65,38	161,19	4,19	62,04	,6131
81	,91103	—	66,20	161,98	4,22	61,74	,6101
82	,91163	—	67,02	162,77	4,25	61,44	,6071
83	,91223	—	67,83	163,55	4,28	61,14	,6042
84	,91282	—	68,65	164,34	4,31	60,85	,6013
100 + 85	,91340	—	69,47	165,13	4,34	60,56	,5985
86	,91398	—	70,28	165,92	4,36	60,27	,5956
87	,91455	—	71,10	166,71	4,39	59,99	,5928
88	,91511	—	71,92	167,49	4,43	59,70	,5900
89	,91567	—	72,74	168,28	4,46	59,42	,5872
100 + 90	,91622	—	73,55	169,07	4,48	59,15	,5845
91	,91677	—	74,37	169,86	4,51	58,87	,5818
92	,91731	—	75,19	170,65	4,54	58,60	,5791
93	,91785	—	76,00	171,44	4,56	58,33	,5764
94	,91838	—	76,82	172,22	4,60	58,06	,5738
100 + 95	,91891	—	77,64	173,01	4,63	57,80	,5712
96	,91942	—	78,45	173,79	4,66	57,54	,5686
97	,91993	—	79,26	174,58	4,68	57,28	,5661
98	,92043	—	80,08	175,37	4,71	57,02	,5635
99	,92093	—	80,90	176,16	4,74	56,76	,5610

TABLE II. HEAT 80°.

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100+100	,92142	100	81,73	176,96	4,77	56,51	,5584
99	,92192	—	82,56	177,77	4,79	56,25	,5559
98	,92242	—	83,40	178,59	4,81	55,99	,5533
97	,92293	—	84,26	179,42	4,84	55,73	,5508
96	,92343	—	85,14	180,27	4,87	55,47	,5482
100 + 95	,92393	—	86,03	181,13	4,90	55,21	,5456
94	,92443	—	86,94	182,02	4,92	54,94	,5429
93	,92493	—	87,87	182,93	4,94	54,67	,5402
92	,92544	—	88,83	183,86	4,97	54,39	,5375
91	,92595	—	89,81	184,81	5,00	54,11	,5347
100 + 90	,92646	—	90,81	185,78	5,03	53,83	,5319
89	,92699	—	91,83	186,77	5,06	53,54	,5291
88	,92753	—	92,87	187,78	5,09	53,26	,5262
87	,92807	—	93,94	188,82	5,12	52,96	,5233
86	,92862	—	95,03	189,88	5,15	52,66	,5204
100 + 85	,92917	—	96,15	190,96	5,19	52,36	,5175
84	,92973	—	97,29	192,07	5,22	52,06	,5144
83	,93029	—	98,46	193,21	5,25	51,75	,5114
82	,93086	—	99,66	194,38	5,28	51,44	,5083
81	,93144	—	100,90	195,58	5,32	51,13	,5052
100 + 80	,93201	—	102,16	196,80	5,36	50,81	,5021
79	,93258	—	103,45	198,07	5,38	50,48	,4989
78	,93315	—	104,77	199,37	5,40	50,15	,4957
77	,93372	—	106,13	200,70	5,43	49,82	,4924
76	,93430	—	107,53	202,07	5,46	49,48	,4890
100 + 75	,93488	—	108,97	203,48	5,49	49,14	,4856
74	,93546	—	110,44	204,93	5,51	48,80	,4822
73	,93605	—	111,95	206,41	5,54	48,45	,4788
72	,93664	—	113,50	207,94	5,56	48,09	,4753
71	,93724	—	115,10	209,51	5,59	47,73	,4717
100 + 70	,93785	—	116,75	211,12	5,63	47,37	,4681
69	,93847	—	118,44	212,78	5,66	47,00	,4645
68	,93910	—	120,18	214,48	5,70	46,62	,4608
67	,93973	—	121,97	216,25	5,72	46,24	,4570
66	,94037	—	123,82	218,06	5,76	45,86	,4532
100 + 65	,94102	—	125,73	219,93	5,80	45,47	,4493
64	,94167	—	127,69	221,86	5,83	45,07	,4454
63	,94232	—	129,72	223,85	5,87	44,67	,4415
62	,94298	—	131,81	225,91	5,90	44,26	,4375
61	,94364	—	133,98	228,04	5,94	43,85	,4334
100 + 60	,94431	—	136,21	230,23	5,98	43,43	,4292
59	,94498	—	138,51	232,50	6,01	43,01	,4250
58	,94565	—	140,89	234,86	6,03	42,58	,4207
57	,94632	—	143,37	237,30	6,07	42,14	,4164
56	,94700	—	145,94	239,83	6,11	41,69	,4120
100 + 55	,94768	—	148,58	242,45	6,13	41,24	,4076
54	,94836	—	151,31	245,16	6,15	40,79	,4031
53	,94904	—	154,16	247,99	6,17	40,33	,3985
52	,94973	—	157,13	250,93	6,20	39,85	,3938
51	,95042	—	160,23	253,99	6,24	39,37	,3891

I. Water and spirit by weight.	II. Specific gravity.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk.	VII. Quantity of spirit *per cent.*	VIII. Decimal multipliers.
W. + Sp.							
100 + 50	,95111	100	163,45	257,16	6,29	38,89	,3843
49	,95181	—	166,79	260,46	6,33	38,39	,3794
48	,95252	—	170,26	263,91	6,35	37,89	,3744
47	,95324	—	173,89	267,50	6,39	37,38	,3694
46	,95395	—	177,66	271,25	6,41	36,86	,3643
100 + 45	,95467	—	181,61	275,18	6,43	36,34	,3591
44	,95538	—	185,74	279,29	6,45	35,81	,3538
43	,95610	—	190,06	283,60	6,46	35,26	,3485
42	,95682	—	194,59	288,11	6,48	34,71	,3431
41	,95754	—	199,33	292,83	6,50	34,15	,3375
100 + 40	,95826	—	204,32	297,79	6,53	33,58	,3319
39	,95898	—	209,56	303,02	6,54	33,00	,3261
38	,95971	—	215,07	308,53	6,54	32,41	,3203
37	,96044	—	220,88	314,34	6,54	31,81	,3144
36	,96118	—	227,02	320,47	6,55	31,20	,3084
100 + 35	,96192	—	233,51	326,92	6,59	30,59	,3023
34	,96266	—	240,37	333,79	6,58	29,96	,2961
33	,96341	—	247,66	341,09	6,57	29,32	,2898
32	,96416	—	255,40	348,83	6,57	28,67	,2833
31	,96492	—	263,64	357,07	6,57	28,01	,2768
100 + 30	,96568	—	272,42	365,85	6,57	27,33	,2701
29	,96645	—	281,82	375,26	6,56	26,65	,2634
28	,96723	—	291,88	385,34	6,54	25,95	,2565
27	,96802	—	302,69	396,16	6,53	25,24	,2495
26	,96882	—	314,33	407,81	6,52	24,52	,2424
100 + 25	,96963	—	326,91	420,42	6,49	23,79	,2351
24	,97045	—	340,53	434,07	6,46	23,04	,2277
23	,97128	—	355,33	448,90	6,43	22,27	,2202
22	,97212	—	371,49	466,09	6,40	21,50	,2125
21	,97298	—	389,18	482,81	6,37	20,71	,2047
100 + 20	,97385	—	408,64	502,32	6,32	19,91	,1967
19	,97473	—	430,14	523,87	6,27	19,09	,1886
18	,97563	—	454,04	547,83	6,21	18,25	,1804
17	,97655	—	480,75	574,59	6,16	17,40	,1720
16	,97749	—	510,79	604,70	6,09	16,54	,1635
100 + 15	,97845	—	544,85	638,83	6,02	15,65	,1547
14	,97943	—	583,76	677,84	5,92	14,75	,1458
13	,98044	—	628,67	722,82	5,85	13,83	,1367
12	,98148	—	681,06	775,30	5,76	12,89	,1275
11	,98256	—	742,97	837,32	5,65	11,94	,1180
100 + 10	,98367	—	817,27	911,70	5,57	10,97	,1084
9	,98482	—	908,08	1002,64	5,44	9,97	,0986
8	,98602	—	1021,59	1116,26	5,33	8,96	,0885
7	,98727	—	1167,53	1262,32	5,21	7,92	,0783
6	,98856	—	1362,12	1457,03	5,09	6,86	,0678
100 + 5	,98991	—	1634,54	1729,58	4,96	5,78	,0571
4	,99131	—	2043,18	2138,36	4,82	4,68	,0462
3	,99278	—	2724,23	2819,54	4,69	3,55	,0350
2	,99432	—	4086,35	4181,79	4,56	2,39	,0236
1	,99592	—	8172,70	8268,26	4,44	1,21	,0120

Specific gravity of water at the different degrees of heat.

Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.	Heat.	Specific gravity.
°		°		°		°		°		°		°		°		°		°	
30	1,00074	35	1,00090	40	1,00094	45	1,00086	50	1,00068	55	1,00038	60	1,00000	65	,99950	70	,99894	75	,99830
31	1,00078	36	1,00092	41	1,00093	46	1,00083	51	1,00063	56	1,00031	61	,99991	66	,99939	71	,99882	76	,99816
32	1,00082	37	1,00093	42	1,00092	47	1,00080	52	1,00057	57	1,00024	62	,99981	67	,99928	72	,99869	77	,99802
33	1,00085	38	1,00094	43	1,00090	48	1,00076	53	1,00051	58	1,00016	63	,99971	68	,99917	73	,99856	78	,99788
34	1,00088	39	1,00094	44	1,00088	49	1,00072	54	1,00045	59	1,00008	64	,99961	69	,99906	74	,99843	79	,99774
																		80	,99759

Although the titles of the Columns in the preceding Tables, with what has been said in the introductory discourse, may render the Tables sufficiently obvious to the generality of readers, yet to some perhaps an example may be necessary; I shall therefore shew in what manner the quantity by measure of pure Spirit of ,825 specific gravity at 60° of heat, may readily be found by the help of these Tables.—In order to which, we must know the heat, the specific gravity, and quantity of spirit which the vessel contains.

EXAMPLE. Suppose the heat to be 35°, the specific gravity ,909, and the quantity of spirit 138,99 measures.

Under 35° of heat, and in Column II. of specific gravity, find ,909; and in the same horizontal line, take out from Column VIII, the decimal multiplier ,7297, by which multiply 138,99, cutting off as many figures to the right as there are decimals in both factors; then we shall have 101,421003 for the measures of pure spirit, of the specific gravity ,825 at 60° of heat.

Now a mere inspection of the Columns in the Tables will shew that a spirit of that strength was obtained, by adding 51 parts of water by weight to 100 parts of spirit, as in Column I. which produced the specific gravity found in the same horizontal line, Column II. It will as readily be seen, that the same specific gravity results from adding together their equivalents in measure, Columns III. and IV. and that Column V. contains the quantity, which the two quantities really measure after the mixture has been made.

ERRATA.

Page 281, column IV. line 34, *for* 126,12, *read* 125,12.
283, —— I. — 17, *for* 100 + 54, *read* 100 + 34.
Ibid. —— IV. — 34, *for* 126,05, *read* 125,05.
Ibid. —— V. — 2 from bottom, *for* 4886,96, *read* 4286,96.
285, —— VIII. — 23, *for* ,5046, *read* ,5056.
286, —— IV. — 8 from bottom, *for* 77,99, *read* 76,99.
287, —— VIII. — 23, *for* ,5044, *read* ,5054.
289, —— II. — 28, *for* ,95485, *read* ,95385.
290, —— IV. — 1 *dele* 0,84.

XXI. *Observations and Experiments on a Wax-like Substance, resembling the* Pé-la *of the* Chinese, *collected at* Madras *by Dr.* Anderson, *and called by him* White Lac. *By* George Pearson, *M. D. F. R. S.*

Read May 29, 1794.

1. *Some Observations relative to the natural History of the Insect which secretes a Sort of Wax, called white Lac.*

The matter which is the subject of the following observations and experiments, was first noticed by Dr. Anderson of Madras, about the year 1786, in a letter to the governor and council of that place, when he says, nests of insects resembling small cowry shells were brought to him from the woods by the natives, who eat them with avidity. These supposed nests he shortly afterwards discovered to be the coverings of the females of an undescribed species of coccus; and having noticed, in the Abbé Grosier's Account of China, that the Chinese collect a kind of wax, much esteemed by them, under the name of Pé-la, from a coccus deposited for the purpose of breeding on certain shrubs, and managed exactly in the same manner as the Mexicans manage the cochineal insect, he followed the same process with his new insects, and shortly found means to propagate them with great facility on several of the trees and shrubs growing in his neighbourhood.

and: R. des Sciences 1741. p. 35

On examining the substance, he observed in it a very considerable resemblance to bees wax; and noticed, moreover, that the animal which secretes it provides itself, by some means or other, with a small quantity of honey, resembling that produced by our bees; and he complains in one of his letters, that the children whom he employed to gather it were tempted by its sweetness to eat so much of what they collected, as to diminish materially the produce of his crop. It is also believed that the white lac possesses medicinal qualities.

A small quantity of this matter was sent to the President in 1789; but as there was not enough for the various experiments which suggested themselves to chemists who were consulted on the occasion, he wrote to Dr. ANDERSON for an additional quantity, who in 1792 furnished him with some pounds of it, both in its natural state, and melted into cakes, as also of the insects adhering to the branches on which they had been cultivated.

The curious analogy between the manner in which this insect produces its wax, and the mode in which it is produced by our bees, according to the late Mr. HUNTER's observation, and the singularity of the animal's producing honey as well as wax, were sufficient reasons, in point of abstract curiosity, to make an analysis very desirable; and moreover the probability of its becoming an object of commerce seemed apparent: for it certainly can be provided at Madras at a much less price than is given for wax, even in the cheapest markets. I therefore, at the request of the President, very willingly undertook the task of examining its chemical qualities, which are the subject of the following paper.

It must be remembered, that all the authors who describe

the true cochineal insect tell us, that the females when nearly perfect are covered thickly with a white down, or meal, which protects them from the sun and rain, and the attacks of certain insects who are their enemies. It is probable that this substance is of the same nature as the pé-la, and that the secretion of wax in more or less quantity is common to the genus of coccus. It is observable, moreover, that the insect which produces lac, a substance resembling wax, provides itself also with a sweet fluid resembling honey. Hence a striking analogy between these three animals is observable; and it is far from improbable that future naturalists may discover them to be species of the same genus; and find the means of making the beautiful red colour produced by the lac insect as useful in dying as that of the true cochineal.

II. *Sensible, and some other Properties of white Lac.*

A piece of white lac, which weighs from about three to fifteen grains, is probably produced by each insect. These pieces are of a grey colour, opaque, rough, and roundish; of about the size of a pea, but with a flat side, by which they adhere to the bark. In this flat side there is a fissure which contains a little black matter, the *exuviæ* of the insect.

White lac, in its dry state, has a saltish and bitterish taste, and in the mouth is soft and tough. It appears however from Mr. Anderson's letter, that the taste of this substance recently produced is "delicious;" so that it is difficult to prevent the children and other persons employed to gather it from eating it.

On pressing a piece of this substance between the fingers, a

watery liquid oozes out, which has a slight salt taste; and we are told that the recently gathered lac is replete with juice.

Although the roundish pieces of this substance yield to pressure between the fingers, they may be broken, and then appear to be perfectly white within, and of an uniform smooth texture. White lac has no smell, unless it be pressed or rubbed till it is soft, and then it emits a peculiar odour.

The lac which had been strained through muslin was of a brown colour throughout its whole substance; was brittle, hard, and had a bitterish taste, without any saltness, for its watery liquid had been separated by melting.

The pieces of lac gathered from the tree are as light, or lighter than bees wax; but after being melted and purified by straining, it sinks in water, and therefore is specifically heavier than bees wax generally is.

White lac melts in water of the temperature of 145° of FAHRENHEIT's thermometer. In boiling water it readily melted, and the black *exuviæ* were thus separated from the lac.

Two thousand grains of white lac were exposed in such a degree of caloric* as was just sufficient to melt them; as they grew soft and fluid, a pretty large quantity of reddish watery fluid, namely 550 grains, which emitted the smell of newly baked bread, oozed out. This liquid was poured off for examination, and the lac was strained through fine cloth repeatedly, till it left no *exuviæ* or other extraneous matter on the filter.

The quantity of purified lac thus obtained was 1220 grains.

* The names of the new system of chemistry are employed in this paper, for which it is presumed a particular explanation is unnecessary, as its nomenclature is now very generally used.

It was yellow like bees wax ; hard and brittle as rosin. It had no bitterish or scarcely any other taste. It melted in alcohol, and also in water, of the temperature of between 145° and 146°.

Purified white lac adheres very firmly to wood, tin, paper, &c. so that it is an excellent cement on many occasions.

III. *Experiments to discover some of the Affinities and Combinations of white Lac.*

1. Yellow purified lac above mentioned was spread thin upon a plate of glass, and exposed to the rays of the sun during the whole of the month of July, 1793, but it was not by this means rendered at all less yellow.

2. A bit of white lac, on boiling in water with powdered charcoal, was absorbed, and disappeared.

3. Purified lac was digested in various proportions of ley of pure pot-ash, in different temperatures, but an uniform or soap-like mass could not be formed. The mixture emitted the smell of palm oil. The lac turned to a brown colour, and had the appearance of a coagulated mass, in the liquid as well as dry state. The liquid filtered from these solutions had a sweetish and bitterish taste. Upon the addition of vinegar, it became very turbid and rose-coloured; and by standing it let fall a copious sediment, which being dried was found to be white lac only rendered more brittle.

4. *Ammoniac*, or *caustic volatile alkali* seemed to combine with the white lac. The compound was a tolerably uniform brown soapy substance. It tasted sweet, and had still a weak smell of ammoniac. It rendered water milky, and this solution became curdy on adding to it acetous acid.

5. Candles, of different thicknesses, were made of purified white lac above mentioned, with cotton wicks of different thicknesses; and candles were also made of white lac which had been dissolved in sulphuric æther, and in volatile oil of turpentine. They all burned more rapidly, but I think emitted a less quantity of light, than wax candles, of the same size. The candles made of white lac also smoked and produced a rosinous smell.

White lac burned in oxygen gaz without affording any smoke, and with a beautifully bright flame.

A small piece of purified white lac, in a platina spoon, was exposed to the apex of the violet blue coloured flame of a candle, by means of the blow-pipe; a small quantity of black matter remained in the spoon, which could not be carried off by a long continued application of the flame; but after keeping the spoon red-hot in the fire for ten minutes, nothing but a very small quantity of grey ash was left.

6. From purified white lac nothing could be extracted by water; nor from the lac in its impure state, except a bitterish mucilage.

7. White lac turned to a black coloured substance by boiling it in concentrated sulphuric acid. The mixture was then diluted with water, and by means of the filter a carbonaceous matter was separated, which on being made red hot burnt in the air without flaming. The filtered liquid, upon evaporation to dryness, afforded no alkaline or other residue.

8. Glass covered with a thin coat of white lac was kept immersed in oxygenated muriatic acid gaz, and also in water saturated with this gaz, for several months, without producing any apparent change on the colour of the lac, or in its other properties.

9. On about 100 grains of white lac were poured 400 grains of concentrated nitrous acid. In a few minutes time the acid became of a deep orange colour, and, on making it hot, nitrous gaz was discharged, with an ebullition of the liquid. A fresh discharge of nitrous gaz took place on adding more nitrous acid. On applying caloric, to make the acid boil and to melt the lac, this substance was totally dissolved; but on standing to cool, it seemed to be wholly separated from the acid, and was rendered white. On diluting with water the acid from which the lac had separated itself, a very slight curdy precipitation took place; and the same appearance took place on adding ley of pot-ash. On evaporating this acid to dryness, a very small residue of lac was obtained. I dissolved a little of this substance by boiling it in concentrated nitrous acid, and poured the solution, while hot, into water; upon which a very copious precipitation instantly took place, of the lac rendered quite white.

10. One hundred grains of the substance under examination were totally dissolved, and very readily, in 500 grains of volatile oil of turpentine. While this solution was hot it was clear, but on cooling it grew opaque and white. On evaporation the whole of the lac was recovered.

11. Fifty grains of white lac readily dissolved in 500 grains measure of sulphuric æther, in the temperature of 80°. This solution was not unctuous, or resinous; the lower part of it was like an emulsion, and the upper part was transparent and limpid; but both parts contained the substance dissolved. Upon evaporation the lac was recovered in the form of a light white powder, which on melting became a brittle yellow solid, as heavy as before solution.

12. One hundred grains of white lac being digested in 1000 grains measure of alcohol, the specific gravity of which was as 835 to 1000, about half of the substance soon dissolved; and the solution when cold was opaque, white, and thick, as saturated solution of soap in hot spirit of wine appears on cooling. By repeated affusions of alcohol on the residue of these 100 grains, all but about 15 grains was dissolved; and this residue did not appear to be different from lac which had not been digested in this menstruum. This solution afforded, on evaporation, a light white opaque powder, which on being melted was a brittle, yellow, heavy solid, as the substance was before solution.

Saturated solution of white lac in alcohol spread upon paper, cloth, wood, &c. on evaporation left a thin coat of resinous matter, which was not however bright and smooth; and therefore this solution did not afford a good varnish.

IV. *Experiments to decompound white Lac by Fire.*

I shall only relate particularly one of these experiments, because among several which I made there was no material difference in the result.

Eight hundred grains of purified white lac were put into a glass retort, to which was affixed an adopter with a large bulb to receive condensed vapours, and the hydro-pneumatic apparatus to collect elastic fluids, or gazes. There distilled over 204 grains of yellow strongly empyreumatic oil of the consistence of butter, 400 grains of thin oil which had the smell of tar, near 20 grains of watery liquid containing a little acid, perhaps the pyrotartareous or the sebacic acid; besides 307

cubic inches of gaz. In the retort there remained 37 grains of carbonaceous matter, which was a pretty hard cinder, the under surface of which in contact with the glass had seemingly undergone a partial fusion, and the glass itself to which it adhered appeared to have been a little corroded.

The above distilled gaz contained no oxygen to the test of nitrous gaz; but 32 cubic inches of it were absorbed by milk of lime, and near 86 cubic inches of it were absorbed by yellow oxyd of lead, or massicot, placed in the focus of a lens; during which absorption lead was reduced, and water composed. The remainder of the gaz extinguished flame, and was concluded to be nitrogen or azotic gaz.

The gaz which was obtained by distillation was therefore a mixture of carbonic acid, hydrogen, and nitrogen gaz. This mixture burnt like what has been called heavy inflammable air.

The above 37 grains of carbonaceous matter afforded two grains of muriate of soda, one grain of carbonate of soda, four grains of phosphate of soda. The lixiviated carbonaceous matter being mixed with 300 grains of red oxyd of lead, and exposed to a due degree of fire, yielded about 60 cubic inches of carbonic acid gaz, and a little regulus of lead; but there was a residue of carbonaceous matter which could not be burnt away in the fiercest fire in open vessels. This residue was probably carbon, phosphoric acid, and soda, intimately mixed by fusion.

From this analysis, it appears that 100 parts of white lac purified yield

Butyraceous oil - - -	25½
Thin oil - - - - -	50
Water containing acid - - -	2½
Carbonaceous matter, containing phosphoric acid, muriatic acid, and soda - -	4½
Carbonic acid, by estimation - -	4
Hydrogen, by estimation - -	1½
Nitrogen or azote, by estimation - -	10
	98
Deficiency by waste and error, by estimation	2
	100 parts.

When this experiment was made with unpurified white lac, the proportion of water and carbonaceous matter was much greater than in the preceding experiment. On account also of the water, it was extremely difficult to prevent the substance boiling over and bursting the vessels.

Charcoal of wood being mixed with white lac, the oil seemed to distil over more readily, with less water, and was paler coloured oil than in the preceding experiment.

White lac was also distilled from pot-ash, without any material difference in the result, excepting that the oils which distilled over were thicker.

v. *Experiments upon the Liquid contained in white Lac.*

(*a*) On pressing, between the fingers, the pieces of white lac, in the state in which they are taken from the tree or shrub (although they are apparently quite dry and brittle, and have been kept several years), a watery liquid oozes out; by which paper stained with turnsole is instantly turned to a red colour.

(*b*) The 550 grains of reddish watery liquid above mentioned to have been separated from 2000 grains of white lac were filtrated through paper in order to separate mucilage.

(*aa*) This filtrated liquid has a slightly saltish taste, with bitterness, but is not at all sour.

(*bb*) When made hot, it smells precisely like newly baked hot bread.

(*cc*) On standing it grows somewhat turbid, and deposits a small quantity of sediment.

(*dd*) Its specific gravity in the temperature of 60° was to distilled water as 1025 to 1000.

(*ee*) A little of this liquid having been evaporated till it grew very turbid, on standing afforded small needle-like crystals in mucilaginous matter.

(*c*) About 250 grains of the liquid (*b*) were poured into a retort which held one ounce measure, to which was joined a receiver containing two shreds of paper, one stained with turnsole, and the other had been dipped in solution of sulphate of iron. As the liquor grew warm, mucilage-like clouds appeared, but when it grew hot they disappeared; and about the temperature of 200° it distilled over very fast. On distillation to nearly dryness, a small quantity of extractive matter remained.

The distilled liquid while hot smelt like newly baked bread, and was perfectly transparent and yellowish. The paper stained with turnsole was not reddened; nor was that which had been immersed in solution of sulphate of iron turned to a blue colour, upon moistening it with ley of pot-ash.

(*d*) The flame of a candle being applied by means of a blow-pipe to the extractive matter (*c*), the whole of it was burnt away, except what produced a black mark upon the spoon; in which no trace of alkali was detected by paper stained with turmeric.

(*e*) About 100 grains of the yellowish transparent liquid (*c*) being evaporated till it grew turbid, after being set by for a night, afforded acicular crystals; which under a lens appeared in a group, not unlike the umbel of parsley. The whole of these crystals could not, probably, have weighed a quarter of a grain. They tasted only bitterish.

(*f*) One hundred grains of the yellowish transparent liquid (*c*) being evaporated, in a very low temperature, to dryness, a blackish matter was left behind, which did not entirely disappear on heating the spoon containing it very hot in the naked fire; but on heating oxalic acid to a much less degree it evaporated, and left not a trace behind.

(*g*) *Carbonate of lime* (chalk) readily dissolved, with effervescence, in the liquid (*c*). The solution tasted bitterish, did not turn paper stained with turnsole to a red colour, and a copious precipitation ensued on adding to it carbonate of pot-ash (mild vegetable alkali). A little of this solution of lime, and also of alkali, being evaporated to dryness, and the residue being made red-hot, nothing remained but carbonate of lime, and carbonate of pot-ash.

(*b*) The above distilled liquid (*c*) did not render nitrate of lime turbid; but

(*i*) It produced turbidness in nitrate and muriate of baryt.

(*k*) To 500 grains of the reddish coloured liquid obtained by melting white lac, I added ley of carbonate of soda, till the effervescence ceased, and the mixture neither reddened paper stained with turnsole, nor turned paper stained with turmeric to a brown colour. The quantity of dry carbonate of soda used in the ley was three grains. A quantity of mucilaginous matter, with a little carbonate of lime, was precipitated during this combination. The saturated solution being filtrated and evaporated to a due degree, it afforded, on standing, deliquescent crystals.

(*l*) A little of the crystallized salt (*k*) by exposure to fire left only a residue of carbonate of soda.

(*m*) The reddish liquid obtained by melting the white lac being filtrated, the following precipitants were added; namely,

1. *Lime-water*, which produced a light purple, turbid appearance, and on standing, there were just perceivable clouds.

2. *Sulphuret of lime* (calcareous liver of sulphur) occasioned a white precipitation; but I could not perceive the smell of sulphurized hydrogen gaz, (hepatic air).

3. *Alcohol of gall nut* (tincture of gall nut) induced a grey precipitation.

4. *Sulphate of iron* (green vitriol) produced a purplish colour, but no precipitation; nor did any precipitation take place on adding to this mixture first a little vinegar, and then a little pot-ash.

5. *Acetite of lead* (sugar of lead) occasioned a reddish precipitation, which re-dissolved on adding a little nitrous acid.

6. *Nitrate of mercury* (solution of mercury in nitrous acid) produced a whitish turbid liquid.

7. *Oxalic acid* produced immediately a precipitation of white acicular crystals.

8. *Tartrite of pot-ash* (soluble tartar) being added, a precipitation took place which much resembled that which takes place on adding tartareous acid to tartrite of pot-ash; but the precipitated matter by the liquid from the white lac did not re-dissolve on adding pot-ash.

With respect to the nature of the liquid contained in white lac, it perhaps belongs to the genus of acids, because it changes turnsole to a red coloured substance, and neutralizes fixed alkali and lime (*g*) (*k*).

This acid liquid is most probably secreted at the same time with the white lac; and therefore the white lac coccus, like the ant, and some other insects, has organs for secreting an acid.

As this acid is destructible by fire (*f*) (*g*) (*l*), and as it affords carbon *(f)*, it must be referred to the animal or vegetable acids.

From the precipitation of tartrite of pot-ash (*m*, 8) resembling tartar, this acid might be supposed to be the tartareous; but as this precipitate is not again dissolved on adding pot-ash; as it has no sour taste (*c*); as it evaporates in 200° of caloric (*b*); as the combination with lime is readily soluble in water, and decomposed by pot-ash (*g*) (*m*, 1); and as the combination with soda is a deliquescent salt (*k*), this acid cannot be considered to be the tartareous. Nor does this liquid appear, from the above experiments, to be any one of the other known vegetable or animal acids. The other proper-

ties, shown by the experiments, except the precipitation of tartrite of pot-ash, and the peculiar smell above mentioned, are either those common to every species of acid, or are possessed by several of them. For although this acid possesses several properties common to all acids, and some properties which belong to a few species only, there is not any one of the already known acids that has the smell, when heated, above mentioned; that precipitates tartrite of pot-ash, but does not serve to compose acidulous tartrite of pot-ash; that, besides having these properties, is vapour in the temperature of 200° without decomposition, has not a sour but a bitterish taste, and forms a soluble compound with lime, which is decomposable by pot-ash.

The precipitation by oxalic acid, it is probable, was occasioned by a small quantity of lime which the undistilled liquid of white lac contains.

The other phænomena in the experiments I do not refer to, because they are produced by acids in general.

Whether the above liquid from white lac be a new acid, or one of the acids already known, but disguised by mixture or union with other bodies, I leave to the decision of future experiments, and to the judgment of learned chemists.

VI. *Remarks and Conclusions from the preceding Observations and Experiments.*

1. White lac being unctuous when in a fluid state; having little or no smell and taste, unless heated; being insoluble in water; being inflammable in oxygen gaz; and decompounded by fire alone, in close vessels, before evaporation, it seems to

belong to the genus of *fat*, or *fixed oils*:—but it differs from them, and resembles the volatile oils and resins, in being brittle and semi-transparent; in being soluble in alcohol; in composing an imperfect soap with fixed alkalies; in dissolving readily in sulphuric æther.

2. As bees wax and white lac seemed to be alike in many properties, I extended the comparison by some experiments on bees wax.

Bees wax when first secreted is, I believe, always white, and it is often white when made into the comb. It remains white after being melted.

White lac becomes yellow, on purification by melting and straining.

Bees wax has a peculiar smell when cold. White lac has a smell only when made hot, and it is a different one from that of bees wax.

Bees wax is less brittle and hard than white lac. The former is, generally, specifically lighter than the latter; for bees wax often floated upon cold water, but purified lac fell to the bottom.

Bees wax melts at about 142°, and therefore in a few degrees less caloric than white lac.

Bees wax does not adhere so firmly to different bodies as white lac.

Yellow bees wax can be rendered white by exposure to the solar light, or by oxygenated muriatic acid, but this lac could not be bleached.

Bees wax formed a soap-like mass by union with pot-ash, which was soluble like common soap in water, but this lac afforded an imperfect soap.

It is well known that bees wax burns without affording almost any smoke or smell, and produces a steady light. I did not find that white lac, united with oil of olive, formed a wax little inferior to bees wax, which is said to be the case with the pé-la of the Chinese. By this union I made white lac whiter and as soft as bees wax; but it still afforded smoke, a resinous smell, and an unsteady light, as before.

Water extracted nothing from pure bees wax.

Nitrous acid, in the cold, only rendered it white; but, on boiling, the lac wholly dissolved, and like the white lac, on cooling, it separated, and was rendered white.

Oil of turpentine, and

Sulphuric æther formed compounds with bees wax similar to those with *white lac*. The solution of bees wax in sulphuric æther, on evaporation left a white powdery substance, which on melting was found to be common yellow wax.

Alcohol, the specific gravity of which to water was as 835 to 1000, dissolved bees wax with much more difficulty, and in much smaller proportion, than *white lac*. By digestion in this menstruum, of the temperature of 130° to 140°, it appeared that bees wax was totally soluble; but the same wax by repeated digestions became more and more difficultly soluble; and yet it did not appear that the last portion of wax was different in its other properties from wax which had not been digested.

On evaporation of this solution to dryness, a white substance in a powdery form remained, which being melted was yellow wax.

Bees wax, on decomposition by fire, in close vessels, with the hydro-pneumatic apparatus affixed, yielded resembling or nearly similar substances to those obtained on the analysis of

white lac by fire; for 1800 grains of bees wax gave 1200 grains of white butyraceous oil, with a little thin brown oil, and a very small quantity of water and acid; and a very large quantity of hydrogen and carbonic acid gaz, with which was probably mixed nitrogen gaz; but an accident prevented me determining the presence of this last gaz. In the retort there remained only about ten grains of carbonaceous matter. The smell of the empyreumatic oils was very different from those of white lac.

3. White lac appears to have the same kinds of affinity as bees wax; but many of their combinations are so very different in the two cases, as to determine white lac and bees wax to be different species of substances, although they agree with one another in more properties than they do with any other known bodies. As to the pé-la of the Chinese, we cannot judge of it unless a more particular account had been given of its qualities.

4. White lac and bees wax appear to be homogeneous substances, and to consist of the same kind of constituent parts, but the proportion of these parts is very different in the two substances; and hence the difference in the properties of bees wax and white lac. I consider the phosphate of lime, the soda, and muriate of soda, as extraneous to the composition of lac. The different composition of the two substances may enable us to explain in a probable manner the different action of other bodies upon them. For instance, as it appears that a much greater proportion of carbon enters into the composition of white lac than bees wax, the quantity of oxygen gaz in atmospheric air, applied under the usual circumstances of combustion, is not sufficient to combine with the

whole of the carbon and other components of a given part of white lac, wherefore a portion of carbon remains uncombined, in the form of soot, or a sublimate; but when oxygen gaz is applied, the whole of the carbon is combined with it, and of course no smoke appears.

The smaller proportion of carbon in bees wax than white lac, affords a probable reason why there is less smoke during the combustion of bees wax than white lac.

It appears reasonable to conclude, that white lac might be made to serve for illumination and combustion as well as bees wax, either by diminishing the proportion of carbon, or by increasing the proportion of the other components; but my knowledge of chemistry does not enable me to effect either of these changes.

XXII. *Account of some remarkable Caves in the Principality of* Bayreuth, *and of the fossil Bones found therein. Extracted from a Paper sent, with Specimens of the Bones, as a Present to the Royal Society, by his most Serene Highness the Margrave of* Anspach, *&c.*

Read January 10, 1793.

A RIDGE of primeval mountains runs almost through Germany, in a direction nearly from west to east; the Hartz, the mountains of Thuringia, the Fichtelberg in Franconia, are different parts of it, which in their farther extent constitute the Riesenberg, and join the Carpathian mountains; the highest parts of this ridge are granite, and are flanked by alluvial and stratified mountains, consisting chiefly of limestone, marl, and sandstone; such at least is the tract of hills in which the caves to be spoken of are situated, and over these hills the main road leads from Bayreuth to Erlang, or Nurenberg. Half way to this town lies Streitberg, where there is a post, and but three or four English miles distant from thence are the caves mentioned, near Gailenreuth and Klausstein, two small villages, insignificant in themselves, but become famous for the discoveries made in their neighbourhood.

The tract of hills is there broken off by many small and narrow vallies, confined mostly by steep and high rocks, here and there overhanging, and threatening, as it were, to fall

and crush all beneath ; and every where thereabouts are to be met with objects, which suggest the idea of their being evident vestiges of some general and mighty catastrophe which happened in the primeval times of the globe.

The strata of these hills consist chiefly of limestone of various colour and texture, or of marl and sandstones. The tract of limestone hills abounds with petrifactions of various kinds.

The main entrance to the caves at Gailenreuth opens near the summit of a limestone hill towards the east. An arch, near seven feet high, leads into a kind of antichamber, 80 feet in length, and 300 feet in circumference, which constitutes the vestibule of four other caves. This antichamber is lofty and airy, but has no light except what enters by its open arch ; its bottom is level, and covered with black mould ; although the common soil of the environs is loam and marl.

By several circumstances it appears, that it has been made use of in turbulent times as a place of refuge.

From this vestibule, or *first cave*, a dark and narrow alley opens in the corner at the south end, and leads into the *second cave*, which is about 60 feet long, 18 high, and 40 broad. Its sides and roof are covered, in a wild and rough manner, with stalactites, columns of which are hanging from the roof, others rising from the bottom, meeting the first in many whimsical shapes.

The air of this cave, as well as of all the rest, is always cool, and has, even in the height of summer, been found below temperate. Caution is therefore necessary to its visitors ; for it is remarkable, that people having spent any time in this or the other caverns, always on their coming out again appear

pale, which in part may be owing to the coolness of the air, and in part likewise to the particular exhalations within the caves. A very narrow, winding, and troublesome passage opens farther into a

Third cave, or chamber of a roundish form, and about 30 feet diameter, covered all over with stalactites. Very near its entrance there is a perpendicular descent of about 20 feet, into a dark and frightful abyss; a ladder must be brought to descend into it, and caution is necessary in using it, on account of the rough and slippery stalactites. When you are down, you enter into a gloomy cave of about 15 feet diameter, and 30 feet high, making properly but a segment of the third cave.

In the passage to this third cave, some teeth and fragments of bones are found; but coming down to the pit of the cave, you are every way surrounded by a vast heap of animal remains. The bottom of this cave is paved with a stalactical crust of near a foot in thickness; large and small fragments of all sorts of bones are scattered every where on the surface of the ground, or are easily drawn out of the mouldering rubbish. The very walls seem filled with various and innumerable teeth and broken bones. The stalactical covering of the uneven sides of the cave does not reach quite down to its bottom, whereby it plainly appears that this vast collection of animal rubbish, some time ago filled a higher space in the cave, before the bulk of it sunk by mouldering.

This place is in appearance very like a large quarry of sandstones; and indeed the largest and finest blocks of osteolithical concretes might be hewn out in any number, if there was but room enough to come to them, and to carry them

out. This bony rock has been dug into in different places, and every where undoubted proofs have been met with, that its bed, or this osteolithical stratum, extends every way far beneath and through the limestone rock, into which and through which these caverns have been made, so that the queries suggesting themselves about the astonishing numbers of animals buried here confound all speculation.

Along the sides of this third cavern there are some narrower openings, leading into different smaller chambers, of which it cannot be said how deep they go. In some of them, bones of smaller animals have been found, such as jaw-bones, vertebræ, and tibiæ, in large heaps. The bottom of this cave slopes toward a passage seven feet high, and about as wide, being the entrance to a

Fourth cave, 20 feet high, and 15 wide, lined all round with a stalactical crust, and gradually sloping to another steep descent, where the ladder is wanted a second time, and must be used with caution as before, in order to get into a cave 40 feet high, and about half as wide. In those deep and spacious hollows, worked out through the most solid mass of rock, you again perceive with astonishment, immense numbers of bony fragments of all kinds and sizes, sticking every where in the sides of the cave, or lying on the bottom. This cave also is surrounded by several smaller ones; in one of them rises a stalactite of uncommon bigness, being four feet high, and eight feet diameter, in the form of a truncated cone. In another of those side grottoes, a very neat stalactical pillar presents itself, five feet in height, and eight inches in diameter.

The bottom of all these grottoes is covered with true animal mould, out of which may be dug fragments of bones.

Besides the smaller hollows, spoken of before, round this fourth cave, a very narrow opening has been discovered in one of its corners. It is of very difficult access, as it can be entered only in a crawling posture. This dismal and dangerous passage leads into a *fifth cave*, of near 30 feet high, 43 long, and of unequal breadth. To the depth of six feet this cave has been dug, and nothing has been found but fragments of bones, and animal mould: the sides are finely decorated with stalactites of different forms and colours; but even this stalactical crust is filled with fragments of bones sticking in it, up to the very roof.

From this remarkable cave, another very low and narrow avenue leads into the last discovered, or the

Sixth cave, not very large, and merely covered with a stalactical crust, in which, however, here and there bones are seen sticking. And here ends this connected series of most remarkable osteolithical caverns, as far as they have been hitherto explored; many more may for what we know exist, hidden, in the same tract of hills.

Mr. ESPER has written a history in German of these caves; and given descriptions and plates of a great number of the fossil bones which have been found there. To this work we must refer for a more particular account of them.

XXIII. *Observations on the fossil Bones presented to the Royal Society by his most Serene Highness the Margrave of* Anspach, *&c. By the late* John Hunter, *Esq. F. R. S. Communicated by* Everard Home, *Esq. F. R. S.*

Read May 8, 1794.

THE bones which are the subject of the present paper, are to be considered more in the light of incrustations than extraneous fossils, since their external surface has only acquired a covering of crystallized earth, and little or no change has taken place in their internal structure.

The earths with which bones are most commonly incrusted are the calcareous, argillaceous, and siliceous, but principally the calcareous; and this happens in two ways; one, the bones being immersed in water in which this earth is suspended; the other, water passing through masses of this earth, which it dissolves, and afterwards deposits upon bones which lie underneath.

Bones which are incrusted seem never to undergo this change in the earth, or under the water, where the soft parts were destroyed; while bones that are fossilized become so in the medium in which they were deposited* at the animal's death. The incrusted bones have been previously exposed to

* Bones that have been buried with the flesh on, acquire a stain which they never lose; and those which have been long immersed in water, receive a considerable tinge.

the open air; this is evidently the case with the bones at present under consideration, those of the rock of Gibraltar, and those found in Dalmatia; and from the account given by the Abbé SPALLANZANI, those of the island of Cerigo are under the same circumstances. They have the characters of exposed bones, and many of them are cracked in a number of places, particularly the cylindrical bones, similar to the effects of long exposure to the sun. This circumstance appears to distinguish them from fossilized bones, and gives us some information respecting their history.

If their numbers had corresponded with what we meet with of recent bones, we might have been led to some opinion of their mode of accumulation; but the quantity exceeds any thing we can form an idea of. In an inquiry into their history three questions naturally arise: did the animals come there and die? or were their bodies brought there, and lay exposed? or were the bones collected from different places? The first of these conjectures appears to me the most natural; but yet I am by no means convinced of its being the true one.

Bones of this description are found in very different situations, which makes their present state more difficultly accounted for. Those in Germany are found in caves. The coast of Dalmatia is said to be almost wholly formed of them, and we know that this is the case with a large portion of the rock of Gibraltar.

If none were found in caves, but in solid masses covered with marl or limestone, it would then give the idea of their having been brought together by some strange cause, as a convulsion in the earth, which threw these materials over them; but this we can hardly form an idea of; or if they had all been

found in caves, we should have imagined these caves were places of retreat for such animals, and had been so for some thousands of years; and if the bones were those of carnivorous animals and herbivorous, we might have supposed that the carnivorous had brought in many animals of a smaller size which they caught for food; and this, upon the first view, appears to have been the case with those which are the subject of this paper; yet when we consider that the bones are principally of carnivorous animals, we are confined to the supposition of their being only places of retreat. If they had been brought together by any convulsion of the earth, they would have been mixed with the surrounding materials of the mountains, which does not appear to be the case; for although some are found sticking in the sides of the caves incrusted in calcareous matter, this seems to have arisen from their situation in the cave. Such accumulation would have made them coeval with the mountains themselves, which from the recent state of the bones I should very much doubt.

The difference in the state of the bones shows that there was probably a succession of them for a vast series of years; for if we consider the distance of time between the most perfect having been deposited, which we must suppose were the last, and the present time, we must consider it to be many thousand years; and if we calculate how long these must still remain to be as far decayed as some others are, it will require many thousand years, a sufficient time for a vast accumulation: from this mode of reasoning, therefore, it would appear that they were not brought here at once in a recent state.

The animal earth, as it is called, at the bottom of these caves, is supposed to be produced by the rotting of the flesh, which is supposing the animals brought there with the flesh on; but I do

conceive, that if the caves had been stuffed with whole animals, the flesh could not have produced one-tenth part of the earth, and to account for such a quantity as appears to be the produce of animals, I should suppose it the remains of the dung of animals who inhabited the caves, and the contents of the bowels of those they lived upon. This is easily conceived from knowing that there is something similar to it, in a smaller degree, in many caves in this kingdom, which are places of retreat for bats in the winter, and even in the summer, as they only go abroad in the evenings; these caves have their bottoms covered with animal earth, for some feet in depth, in all degrees of decomposition, the lowermost the most pure, and the uppermost but little changed, with all the intermediate degrees; in which caves are formed a vast number of stalactites, which might incrust the bones of those that die there.

The bones in the caves in Germany are so much the object of the curious, that the specimens are dispersed throughout Europe, which prevents a sufficient number coming into the hands of any one person to make him acquainted with the animals to which they belong.

From the history and figures given by ESPER, it appears that there are the bones of several animals; but what is curious, they all appear to have been carnivorous, which we should not have expected. There are teeth in number, kind, and mode of setting, exactly similar to the white bear, others more like those of the lion; but the representations of parts, however well executed, are hardly to be trusted to for the nicer characters, and much less so when the parts are mutilated.

The bones sent by his highness the Margrave of ANSPACH agree with those described and delineated by ESPER as belonging to the white bear; how far they are of the same species

among themselves, I cannot say; the heads differ in shape from each other; they are, upon the whole, much longer for their breadth than in any carnivorous animal I know of; they also differ from the present white bear, which, as far as I have seen, has a common proportional breadth; it is supposed, indeed, that the heads of the present white bear differ from one another, but the truth of this assertion I have not seen heads enough of that animal to determine.

The heads not only vary in shape, but also in size, for some of them, when compared with the recent white bear, would seem to have belonged to an animal twice its size, while some of the bones correspond in size with those of the white bear, and others are even smaller.*

There are two ossa humeri, rather of a less size than those of the recent white bear; a first vertebra, rather smaller; the teeth also vary considerably in size, yet they are all those of the same tribe; so that the variety among themselves is not less than between them and the recent. In the formation of the head, age makes a considerable difference; the skull of a young dog is much more rounded than an old one, the ridge leading back to the occiput, terminating in the two lateral ones, hardly exists in a young dog; and among the present bones there is the back part of such a head, yet it is larger than the head of the largest mastiff; how far the young white bear may vary from the old, similar to the young dog, I do not know, but it is very probable. Drawings of the different heads and ossa humeri, done in a very

* It is to be understood, that the bones of the white bear that I have, belonged to one that had been a show, and had not grown to the full or natural size; and I make allowance for this in my assertion, that the heads of those incrusted appear to belong to an animal twice the size of our white bear.

masterly manner by Mr. BATTY, surgeon in Great Marlborough-street, who was so obliging as to take that trouble, are annexed to this account. See Tab. XIX. and XX.

Bones of animals under circumstances so similar, although in different parts of the globe, one would have naturally supposed to consist chiefly of those of one class or order in every place, one principle acting in all places. In Gibraltar they are mostly of the ruminating tribe, of the hare kind, and the bones of birds; yet there are some of a small dog or fox, and likewise shells. Those in Dalmatia appear to be mostly of the ruminating tribe, yet I saw a part of the os hyoides of a horse; but those from Germany are mostly carnivorous. From these facts we should be inclined to suppose, that their accumulation did not arise from any instinctive mode of living, as the same mode could not suit both carnivorous and herbivorous animals.

In considering animals respecting their situation upon the globe, there are many which are peculiar to particular climates, and others that are less confined, as herrings, mackerel, and salmon; others again, which probably move over the whole extent of the sea, as the shark, porpus, and whale tribe; while many shell-fish must be confined to one spot. If the sea had not shifted its situation more than once, and was to leave the land in a very short time, then we could determine what the climate had formerly been by the extraneous fossils of the stationary animals, for those only would be found mixed with those of passage; but if the sea moves from one place to another slowly, then the remains of animals of different climates may be mixed, by those of one climate moving over those of another, dying, and being fossilized; but this I am afraid cannot be made out. By the fossils we may, however, have some idea

how the bones of the land animals fossilized may be disposed with respect to those of the sea.

If the sea should have occupied any space that never had been dry land prior to the sea's being there, the extraneous fossils can only be those of sea animals; but each part will have its particular kind of those that are stationary mixed with a few of the amphibia, and of sea birds, in those parts that were the skirts of the sea. I shall suppose that when the sea left this place it moved over land where both vegetables and land animals had existed, the bones of which will be fossilized, as also those of the sea animals; and if the sea continued long here, which there is reason to believe, then those mixed extraneous fossils will be covered with those of sea animals. Now if the sea should again move and abandon this situation, then we should find the land and sea fossils above mentioned disposed in this order; and as we begin to discover extraneous fossils in a contrary direction to their formation, we shall first find a stratum of those of animals peculiar to the sea, which were the last formed, and under it one of vegetables and land animals, which were there before they were covered by the sea, and among them those of the sea, and under this the common earth. Those peculiar to the sea will be in depth in proportion to the time of the sea's residence and other circumstances, as currents, tides, &c.

From a succession of such shiftings of the situation of the sea we may have a stratum of marine extraneous fossils, one of earth, mixed probably with vegetables and bones of land animals, a stratum of terrestrial extraneous fossils, then one of marine productions; but from the sea carrying its inhabitants along with it, wherever there are those of land animals there

will also be a mixture of marine ones; and from the sea commonly remaining thousands of years in nearly the same situation, we have marine fossils unmixed with any others.

All operations respecting the growth or decomposition of animal and vegetable substances go on more readily on the surface of the earth than in it; the air is most probably the great agent in decomposition and combination, and also a certain degree of heat. Thus the deeper we go into the earth, we find the fewer changes going on; and there is probably a certain depth where no change of any kind can possibly take place. The operation of vegetation will not go on at a certain depth, but at this very depth a decomposition can take place, for the seed dies, and in time decays; but at a still greater depth, the seed retains its life for ages, and when brought near enough to the surface for vegetation, it grows. Something similar to this takes place with respect to extraneous fossils; for although a piece of wood or bone is dead, when so situated as to be fossilized, yet they are sound and free from decomposition, and the depth, joined with the matter in which they are often found, as stone, clay, &c. preserves them from putrefaction, and their dissolution requires thousands of years to complete it; probably they may be under the same circumstances as in a vacuum; the heat in such situations is uniform, probably in common about 52° or 53°, and in the colder regions they are still longer preserved.

I believe it is generally understood that in extraneous fossils the animal part is destroyed; but I find that this is not the case in any I have met with.

Shells, and bones of fish, most probably have the least in quantity, having been longest in that state, otherwise they

should have the most; for the harder and more compact the earth, the better is the animal part preserved; which is an argument in proof of their having been the longest in a fossil state. From experiment and observation, the animal part is not allowed to putrefy, it appears only to be dissolved into a kind of mucus, and can be discovered by dissolving the earth in an acid; when a shell is treated in this way, the animal substance is not fibrous or laminated, as in the recent shell, but without tenacity, and can be washed off like wet dust; in some, however, it has a slight appearance of flakes.

In the shark's tooth, or glosso-petra, the enamel is composed of animal substance and calcareous earth, and is nearly in the same quantity as in the recent; but the central part of the tooth has its animal substance in the state of mucus interspersed in the calcareous matter.

In the fossil bones of sea animals, as the vertebræ of the whale, the animal part is in large quantity, and in two states; the one having some tenacity, but the other like wet dust: but in some of the harder bones it is more firm.

In the fossil bones of land animals, and those which inhabit the waters, as the sea-horse, otter, crocodile, and turtle, the animal part is in considerable quantity. In the stags horns dug up in Great Britain and Ireland, when the earth is dissolved, the animal part is in considerable quantity, and very firm. The same observations apply to the fossil bones of the elephant found in England, Siberia, and other parts of the globe; also those of the ox kind; but more particularly to their teeth, especially those from the lakes in America, in which the animal part has suffered very little; the inhabitants find little difference in the ivory of such tusks from the

recent, but its having a yellow stain; the cold may probably assist in their preservation.

The state of preservation will vary according to the substance in which they have been preserved; in peat and clay I think the most; however, there appears in general a species of dissolution; for the animal substance, although tolerably firm, in a heat a little above 100° becomes a thickish mucus, like dissolved gum, while a portion from the external surface is reduced to the state of wet dust.

In incrusted bones, the quantity of animal substance is very different in different bones. In those from Gibraltar there is very little; it in part retains its tenacity, and is transparent, but the superficial part dissolves into mucus.

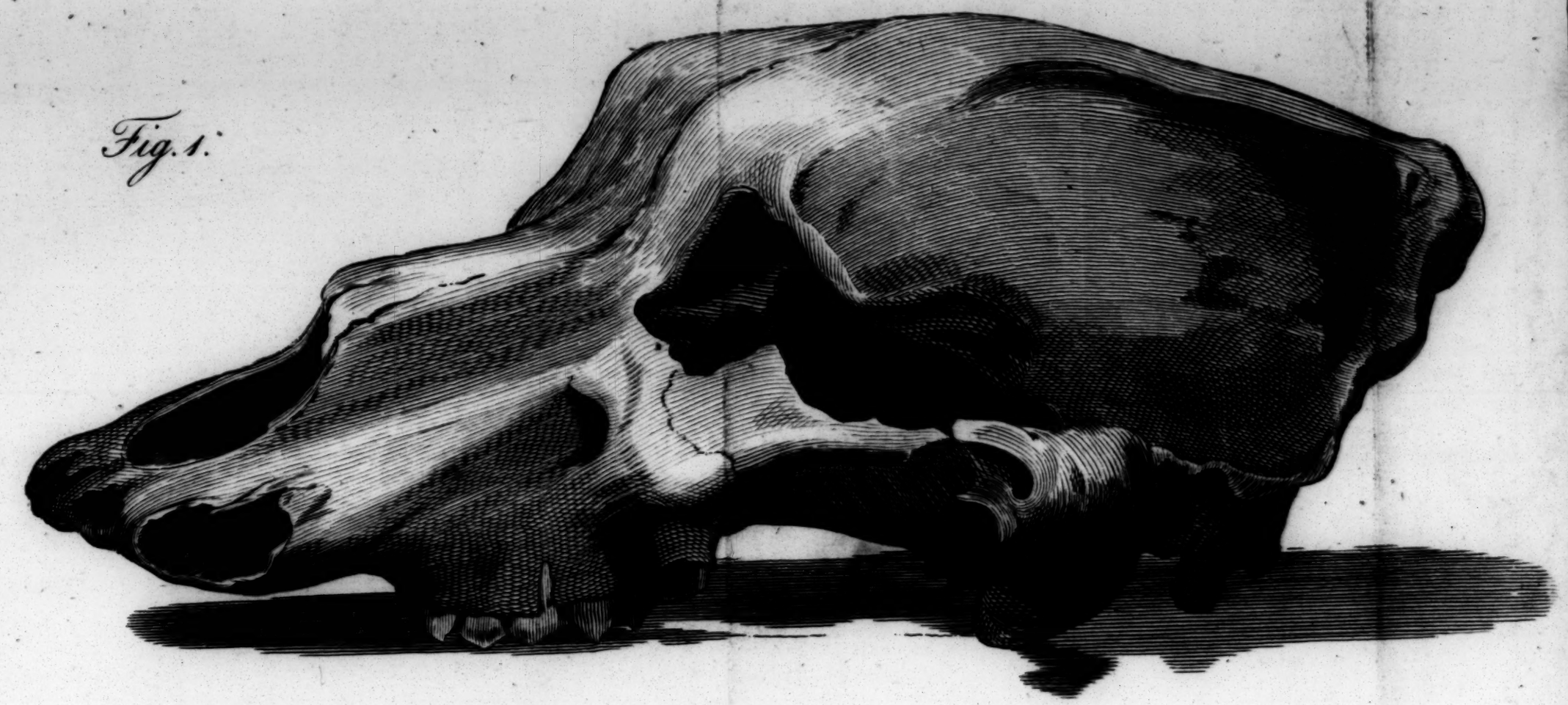
Those from Dalmatia give similar results when examined in this way.

Those from Germany, especially the harder bones and teeth, seem to contain all the animal substance natural to them, they differ however among themselves in this respect.

The bones of land animals have their calcareous earth united with the phosphoric acid instead of the aerial, and I believe, retain it when fossilized, nearly in proportion to the quantity of animal matter they contain.

The mode by which I judge of this, is by the quantity of effervescence; when fossil bones are put into the muriatic acid it is not nearly so great as when a shell is put into it, but it is more in some, although not in all, than when a recent bone is treated in this way, and this I think diminishes in proportion to the quantity of animal substance they retain; as a proof of this, those fossil bones which contain a small portion of animal matter, produce in an acid the greatest effervescence when the

Fig. 1.



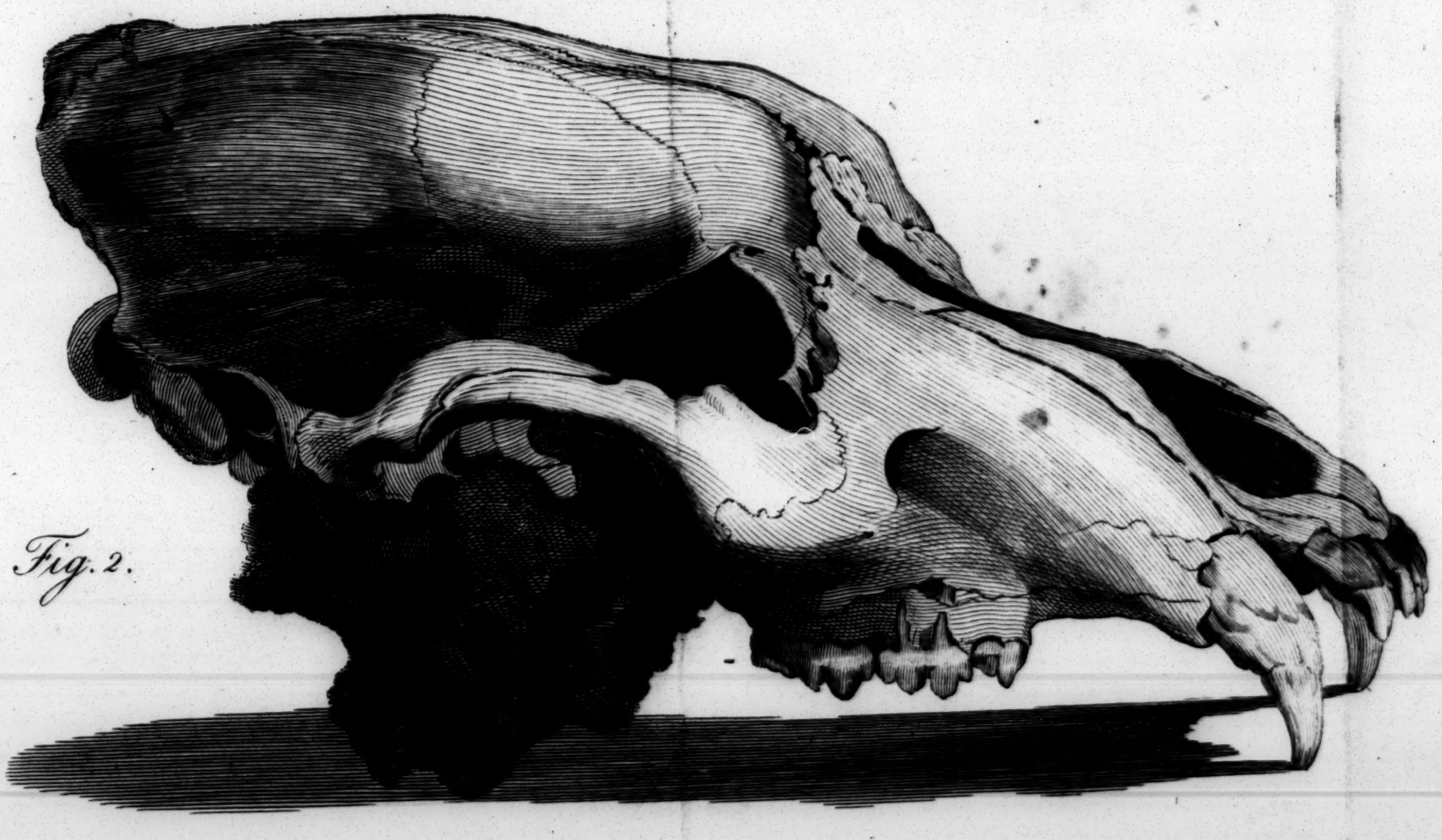


Fig. 2.

Basire sc.

Fig. 1.

Fig. 2.

Byfield Sc.

surface is acted on, and very little when the centre is affected by it; however, this may be accounted for by the parts which have lost their phosphoric acid, and acquired the aerial, being easiest of solution in the marine acid, and therefore dissolved first, and the aerial acid let loose.

In some bones of the whale the effervescence is very great; in the Dalmatia and Gibraltar bones it is less; and in those the subject of the present paper it is very little, since they contain by much the largest proportion of animal substance.

EXPLANATION OF THE PLATES.

Tab. XIX.

Fig. 1. One of the incrusted skulls sent over by the Margrave of ANSPACH, which is much larger than that of the common white bear, longer for its breadth, and having a greater hollow between the anterior part of the skull and the bones of the face.

Fig. 2. Another skull, which differs in many respects from fig. 1. and nearly in the same degree that the first does from the skull of the recent white bear.

Tab. XX.

Fig. 1. A portion of a skull; to what animal it belongs is not exactly ascertained, unless it be the growing state of the bones in one of the varieties of the white bear species, but it is materially different from the full grown skulls expressed in Tab. XIX. It is rather too large in proportion to the others.

Fig. 2. Two of the incrusted ossa humeri, to shew that these bones vary very much among themselves, these two being in many respects dissimilar.

XXIV. *Account of a mineral Substance, called* Strontionite, *in which are exhibited its external, physical, and chemical Characters.* *By Mr.* John Godfrey Schmeisser, *F. R. S.*

Read May 29, 1794.

THIS substance has obtained its name from the place *Strontion*, in Scotland, where it is found in granite rocks, accompanied by galena and witherite, which latter is described by Dr. WITHERING in the Philosophical Transactions of the year 1784.

On all the specimens which I have seen of this substance, I could not discover any regular crystallized shape, like the witherite.

The specimen which I submitted to experiments, was in solid masses of a fibrous texture, apparently composed of long fibres, closely adhering to each other, and disposed in a radiated manner; its colour was an asparagus green, which appeared deeper towards the centre of the mass; when broken, the surface was a little shining in certain directions, the fragments rather bar-like, and somewhat brittle.

Some specimens exhibit only light shades of this colour, and appear to be composed of long thin bars, which are often separated from each other towards the extremity.

The specimen which I examined, and used for experiments, was semitransparent, but the most part of it rather inclining to opaque.

As to hardness, its surface could be scratched with a hard knife, but not scraped.

Its specific gravity I found as 3,586, compared to distilled water of 60° temperature.

Properties of the Substance.

N. B. The first experiments, which pointed out a distinction between its basis and the ponderous earth of SCHEELE, were made, at Dr. CRAWFORD's desire, by his assistant Mr. CRUIKSHANK, and were afterwards repeated by himself; the account of which is inserted in the second volume of the Medical Communications.

EXPERIMENT I.

I reduced a certain quantity of the substance to a very fine powder, and boiled it in water for some time, but no solution took place.

EXPERIMENT II.

With acids. It was not affected by sulphuric acid; but was entirely soluble in nitric and muriatic acid, with a strong effervescence, during which a great quantity of gaz was disengaged, which when tried, was entirely absorbed by lime-water, extinguished flame, and had no smell.

EXPERIMENT III.

Diluted sulphuric acid dropped into a diluted solution of this substance in nitric and marine acid, occasioned a white powdery precipitate, which was insoluble in water.

EXPERIMENT IV.

A piece of the substance was exposed to the action of the blow-pipe, did not crackle nor split asunder, nor did it melt when even exposed to white heat, but it discovered a very bright phosphorescent light, became more brittle, and had lost its greenish cast; it was then partly soluble in water.

It only lost a very little of its weight, when exposed for a long time to white heat, but it then still effervesces with acids.

EXPERIMENT V.

It melted with borax and soda with ebullition, but neither a blue nor a green colour was produced when melted with the first.

EXPERIMENT VI.

Liquid volatile alkali did not extract any blue colour from the powdered substance, nor when added to the solution in acids.

EXPERIMENT VII.

The solutions in nitric and muriatic acid were colourless, and a piece of paper dipped into this nitric solution burnt with a red flame, which was first observed by Dr. ASH.

EXPERIMENT VIII.

Phlogisticated alkali, or prussiate of pot-ash, added to a saturated solution, discovered a very slight quantity of blue precipitate.

EXPERIMENT IX.

Oxalic acid, or acid of sugar, added to the diluted solution, discovered a very slight precipitate.

EXPERIMENT X.

The remaining liquid of the foregoing experiment was mixed with sulphuric acid, until no more precipitate took place, the remaining filtered liquor was saturated with purified pot-ash, and no earth was separated or discovered.

EXPERIMENT XI.

A certain quantity of the powdered substance was dissolved, and saturated with nitric acid, and evaporated; it then crystallized; the crystals were permanent in air, did not deliquesce, and exhibited triangular and sexangular plates.

EXPERIMENT XII.

When dissolved and saturated with muriatic acid, it exhibited on evaporation long six-sided prismatic crystals, which have the broad alternating with the narrow sides, terminating in obtuse trihedral pyramids; this was observed by Dr. CRAWFORD, who also found *that the salt formed of the substance with acids dissolved in water, produced five times more cold than the salt from the barytes in the same acid; that the salt formed by marine acid and this substance, was much more soluble in warm water than in cold, whilst the muriat of barytes is nearly as soluble in cold as in warm water; that one ounce of distilled water dissolves three times as much of the muriat of Strontionite as the muriat of barytes, which makes a distinction between the basis of this substance and the barytes.*

EXPERIMENT XIII.

Nitric acid added to the solution of that substance in muriatic acid, occasioned a decomposition.

EXPERIMENT XIV.

A quantity of this substance was dissolved in muriatic acid, the solution much diluted with distilled water, and afterwards precipitated by diluted sulphuric acid. The precipitate was dried and decomposed by purified pot-ash, by means of heat.

The earth which was thus separated, was perfectly freed from saline parts, afterwards dried and calcined, in order to deprive it of moisture. A quantity of this earth was again dissolved in acid, in order to ascertain the quantity of carbonic acid, or fixed air, which it contained, and the real proportion of pure earth contained in a certain quantity.

I then found by accurate experiments,

1st. That 100 grains of specific sulphuric acid required 133 grains of the pure earth for saturation.

2dly. That 100 grains of nitric acid required 94 grains, and

3dly. That 100 grains of muriatic acid required 56 grains for saturation. Which experiment ascertained the dormant affinity of this earth to those acids.

I also ascertained in the same way,

1st. That 100 grains of sulphuric acid required 130 grains of barytes.

2dly. That 100 grains of nitric acid required 120 grains, and

3dly. That the same quantity of muriatic acid required 96 for saturation, which gave the dormant affinity betwixt the barytes and those acids.

From these experiments I drew the following conclusions.

1st. That according to experiment 1. the substance contained no saline parts.

2dly. That according to experiment 11. it contained fixed air.

3dly. That according to experiment III. it contained an earth somewhat similar to barytes.

4thly. That according to experiment IV. it discovers no crystallizing water.

5thly. That according to experiment V. the substance contained no cobalt.

6thly. That according to experiment VI. the substance contained no copper.

7thly. That according to experiment VIII. it contained a little iron.

8thly. That according to experiment IX. the substance contained calcareous earth.

9thly. That according to experiment X. the substance contained no argillaceous nor magnesian earth.

10thly. That according to the last experiment, the base of this substance is distinct from the barytes.

In order to ascertain the quantity or proportion of component parts of this substance,

EXPERIMENT I.

One hundred grains were dissolved in acid, and yielded 30 grains of fixed air.

EXPERIMENT II.

The solution was diluted, and mixed with oxalic acid, by means of which half a grain of calcareous earth was separated (in the state of oxalate of lime).

EXPERIMENT III.

The remaining solution was decomposed, and yielded 68 grains of pure earth.

According to these experiments, 100 grains of the analyzed substance contains 30 grains of fixed air, 1 of calcareous, and 68 grains of another earth, which may be called *Strontion earth*, and the remaining weight may be accounted for, from the substance which gives it the colour, and which I suggest, from comparative experiments, to be phosphate of iron and manganese; the proportion of which I could not accurately ascertain, on account of the smallness of the specimen which I possessed, and which I employed for analysis; but which I shall endeavour to ascertain by future experiments on a larger scale.

In order to compare the nature of the substance with which it was accompanied to the before-mentioned substance, I made the following experiments.

This substance was crystallized in six-sided prisms with pyramids, colourless, semitransparent, rather opaque towards the basis, and less hard than the other substance; a certain quantity of it I reduced to fine powder, and submitted it to various experiments, by which I found that it contained barytes, calcareous earth, and carbonic acid.

One hundred grains of this substance were dissolved in marine acid, during which 15 grains of carbonic acid were separated; the solution was gently evaporated, and exposed to crystallize. The crystals were then exposed for some time to air in a funnel, during which part of the crystals had deliquesced. When no more deliquescence was observed, the whole liquor was diluted with a sufficient quantity of distilled water, and diluted sulphuric acid was then added, by means of which 2 grains of barytes were separated. The filtered liquor was then decomposed by alkali, and 12 grains of calcareous earth were separated. The dry crystals remaining on the

funnel were then dissolved in distilled water, and also decomposed by alkali, by means of which 68 grains of barytes were obtained.

According to these experiments, 100 grains of this crystallized substance yielded by decomposition 70 grains of barytes, 15 grains of carbonic acid, and 12 grains of calcareous earth. The difference of the 3 remaining grains may be accounted for by the water, by the small loss which was observed when the crystallized substance was exposed to a strong heat, and also from the crackling which was perceived when exposed to a sudden heat. Whether this crystallized substance is different from that specimen which Dr. WITHERING analyzed, or whether the calcareous earth escaped his observation during his experiments, I cannot decide, as he does not mention that he employed the substance in a crystallized state for his experiments.*

* The experiments newly communicated by Mr. KIRWAN, and those which are promised to be communicated by Dr. HOPE, will probably throw some more light on the nature of the Strontionite.

XXV. *Account of a spontaneous Inflammation.* *By* Isaac Humfries, *Esq.* *In a Letter from* Thomas B. Woodman, *Esq. to* George Atwood, *Esq. F. R. S.*

Read July 10, 1794

DEAR SIR, Ewell, June 9, 1794.

I INCLOSE you the extract of the letter from ISAAC HUMFRIES, Esq. a gentleman resident in India, and employed in the Company's service, which relates to the circumstance of the fire I lately mentioned to you.

And am yours, &c.

THOMAS B. WOODMAN.

" ON going into the arsenal a few mornings since, I found my friend Mr. GOLDING, the commissary of stores, under the greatest uneasiness in consequence of an accident which had happened the preceding night. A bottle of linseed oil had been left on a table, close to which a chest stood, which contained some coarse cotton cloth; in the course of the night the bottle of oil was thrown down, and broken on the chest (by rats most probably), and part of the oil ran into the chest, and on the cloth: when the chest was opened in the morning,

the cloth was found in a very strong degree of heat, and partly reduced to tinder, and the wood of the box discoloured, as from burning. After a most minute examination, no appearance of any other inflammable substance could be found, and how the cloth could have been reduced to the condition in which it was found, no one could even conjecture. The idea which occurred, and which made Mr. GOLDING so uneasy, was that of an attempt to burn the arsenal. Thus matters were when I joined him, and when he told me the story and shewed me the remainder of the cloth. It luckily happened that in some chemical amusements, I had occasion to consult HOPSON's book a very few days before, and met with this particular passage, which I read with a determination to pursue the experiment at some future period, but had neglected to do so. The moment I saw the cloth, the similarity of circumstances struck me so forcibly, that I sent for the book and shewed it to Mr. GOLDING, who agreed with me that it appeared sufficient to account for the accident. However, to convince ourselves, we took a piece of the same kind of cloth, wetted it with linseed oil, and put it into a box, which was locked and carried to his quarters. In about three hours the box began to smoke, when on opening it, the cloth was found exactly in the same condition as that which had given us so much uneasiness in the morning, and on opening the cloth, and admitting the external air, it burst into fire. This was sufficiently convincing; however, to make it more certain, the experiment was three times tried, and with the same success."

P. S. The passage Mr. HUMFRIES alludes to is in page 629 of HOPSON's Chemistry, where, in a note, you will find mention

made of a set of chemical experiments made on inflammable substances by a Mr. GIORGI of the Imperial Academy of Petersburgh, in consequence of the burning of a Russian frigate at Cronstadt in 1781, although no fire had been made on board of her for five days before.

XXVI. *An Account of an Appearance of Light, like a Star, seen in the dark Part of the Moon, on Friday the 7th of March, 1794, by* William Wilkins, *Esq. at* Norwich. *In Extracts of a Letter to the Rev.* Samuel Vince, *F. R. S. and of three Letters to the Rev.* Nevil Maskelyne, *D. D. F. R. S. and Astronomer Royal; and communicated by the latter.*

Read July 10, 1794.

LETTER I.

REVEREND SIR, Norwich, 17th April, 1794.

I RECEIVED your letter yesterday; and I am extremely happy in giving you the best description in my power respecting the phænomenon I saw in the moon, on Friday the 7th of March, a few minutes before eight o'clock in the evening. I was in hopes, as it was a bright evening, that some astronomer might observe it, who would have described it in a more *scientific* manner than I can. The few observations I made were merely to compare with some account I expected and wished to meet in some periodical publication.

My friend Mr. BECKWITH having the day before told me that I might see Mercury soon after sun-set, I had been looking for that planet from the Castle-hill in Norwich, but was disappointed by a clouded horizon. I mention this merely as the reason of my being led to a more particular notice of the moon also in this evening, having lost the first object of that evening's attention.

When I saw the light speck, as shewn in the sketch, (see Tab. XXI. fig. 1.) I was very much surprised; for, at the instant of discovery I believed a star was passing over the moon, which on the next moment's consideration I knew to be impossible. I remembered having seen, at some periods of the moon, detached lights from the serrated edge of light, through a telescope; but this spot was considerably too far distant from the enlightened part of the moon; besides, this was seen with the naked eye. I was, as it were, rivetted to the spot where I stood, during the time it continued, and took every method I could imagine to convince myself that it was not an error of sight; and two persons, strangers, passed me at the same time, whom I requested to look, and they (may be, a little more ignorant than myself) said it was a star. I am confident I saw it five minutes at least; but as the time is only conjectural, it might not, possibly, be so long.

The spot appeared rather brighter than any other enlightened part of the moon. IT WAS THERE WHEN I FIRST LOOKED. The whole time I saw it, it was a FIXED, STEADY LIGHT, except the moment before it disappeared, when its brightness INCREASED; but that appearance was instantaneous.

I have a reflecting telescope, and as I was very near home, I had determined to return and use it on this occasion; for it was so fixed, I had scarcely a doubt but its appearance would continue; but almost at the instant, and whilst I was looking, it totally disappeared. You can tell, by the age of the moon at that time, the apparent breadth of light upon the surface of that body, which, as near as I can judge, determines the distance of the spot from two points, B and C, on the periphery of the circle, (see fig. 1.) in which A is the enlightened spot; B A = A D = D C; B A D is supposed a right angle.

I mentioned this soon afterwards to a gentleman of my acquaintance, who sometimes amuses himself in the study of astronomy; he was extremely inquisitive about it, and conjectured this phænomenon to be some great volcanic convulsion in the moon, which induced me at that time to assist my memory with a sketch like what I have here sent you. I shall be obliged to you, Sir, if you will favour me with Dr. MASKELYNE's opinion, if what I have related is sufficient ground for him to form an opinion upon; and whether any such phænomenon has ever before been observed. When I was lately in town, I mentioned the particulars to my worthy friend Mr. H. REPTON, and if my engagements would have permitted, he was desirous I should call with him upon Dr. HERSCHEL, with whom he has some acquaintance.

I am, &c.

WILLIAM WILKINS.

Norwich,
17th April, 1794.

To the Rev. SAMUEL VINCE.

LETTER II.

REVEREND SIR, Norwich, 2d May, 1794.

I am favoured with your letter of the 1st instant, respecting the description of the light spot observed by me in the moon.

I am certain as to the evening I saw the phænomenon, because I made the memorandum in a pocket journal I keep; besides, another local circumstance convinces me of its being on a Friday, and not on any other day than the 7th of March.

You are undoubtedly right in supposing I had forgot how near the moon was to a half moon; and when I wrote to Mr. VINCE, I answered him in haste; for his letter to me requested

an immediate answer, on account of his engagement to leave Cambridge in a short time. If you will please to refer to my letter, I think you will find I was somehow aware of my not describing the age of the moon properly in the sketch; for I said, "*you will be able to tell* by the age of the moon at that "time, *the apparent breadth of light*, which may, in some mea- "sure, determine the situation of the spot according to my "idea."

The sketch I made at first was in pencil, without the assistance of compasses.

It appeared like a small star, without changing its form or situation; and its distance was as far from the enlightened edge D as from the dark edge B.

I am, &c.

WILLIAM WILKINS.

To the Rev. Dr. MASKELYNE.

LETTER III.

REVEREND SIR, Norwich, 8th May, 1794.

I am again favoured with yours of the 6th instant. The evening I saw the bright spot on the moon, I had been looking for Mercury soon after sun-set, and walked more than an hour; and having been disappointed by a clouded horizon, I returned home (my house is within 50 yards of the Castle-hill); and after staying some time, set out again to the coffee-house to look at the papers, as I usually do about that time, *i. e.* eight o'clock. I took the Castle-hill again in my way, when I was surprised with the appearance I have already described. After the disappearance of the phænomenon, I was very

particular in my inquiries respecting the time, and called purposely on a neighbour* to ascertain it with certainty; and found it a few minutes before eight o'clock, which time I entered in my pocket journal; and on inquiry of Mrs. WILKINS, she says I left home at that time.

I am in my 44th year, and have a strong, good sight, not in the least short sighted. About two years since, I purchased a pair of spectacles in town, because I did not, in pointing a pen, see the nib so distinctly as formerly; but notwithstanding, they lay in my drawer totally useless.

My profession has lately carried me frequently to Orfordness, where I have been constructing a lighthouse for Lord HOWARD, upon the new principle, with ARGAND lamps and reflectors; and the goodness of my sight has often been remarked, in discovering vessels with the *naked eye*, which my companions could not discover but with the telescope. I find that by looking some time at an object, my left eye waters, I suppose from weakness; but if I shut it, my other eye still remains strong sighted. When the moon is young, I do perfectly see the whole circumference, from the faint light which surrounds it; and on that evening the moon appeared a well defined crescent.

I remember seeing the star you mention that evening; but I think it was between nine and ten o'clock that I observed it; and it was in appearance, may be, two of the moon's diameters distance to the west; but I did not particularly notice it.

I am very certain of this spot appearing WITHIN the circumference of the moon's circle.

I am, &c. **WILLIAM WILKINS.**

Castle Meadow.
To the Rev. Dr. MASKELYNE.

* Mr. R. BACON, who is publisher of one of the Norwich papers.

LETTER IV.

SIR, Hare-street, by Romford, 26th May, 1794.

Having been some days from Norwich, I received your favour of the 23d instant only this morning. The clocks at Norwich are regulated by mean time, in the same manner as in London. I have herewith given the figure you request, copying the moon's appearance from your scheme, not having any of my former sketches with me (see fig. 2.); I have placed the spot of light to the best of my recollection; and I hope it is such as will be the means of satisfying your curious inquiries.

I am, &c.

WILLIAM WILKINS.

To the Rev. Dr. MASKELYNE.

XXVII. *An Account of an Appearance of Light, like a Star, seen lately in the dark Part of the Moon, by* Thomas Stretton, *in St.* John's Square, Clerkenwell, London; *with Remarks upon this Observation, and Mr.* Wilkins's. *Drawn up, and communicated by the Rev.* Nevil Maskelyne, *D. D. F. R. S. and Astronomer Royal.*

Read July 10, 1794.

Mr. Vince, Fellow of this Society, having acquainted me by letter, early in April last, that a gentleman at Norwich had a month before seen a bright spot upon the dark part of the moon, and had made a little drawing of it in his pocket-book, which he promised to send to him, I immediately wrote a letter in answer to Mr. Vince, to desire him to request the gentleman to send the drawing he had promised, and a full account of the phænomenon. Mr. Vince accordingly wrote to the gentleman immediately, Mr. William Wilkins, architect at Norwich, which produced the first of the foregoing letters, and addressed by Mr. Wilkins to him, giving a particular account of his observation, with a drawing of the appearance.

Soon after, my relation Sir George Booth, Bart. with his lady, being on a visit at the Royal Observatory, upon my mentioning Mr. Wilkins's observation, Lady Booth said their servant, who is curious for a person in his situation, and fond of looking at the stars, had some time before seen something

extraordinary in the moon. Upon this I took occasion, on the 28th of April, to question the man about it, taking care at the same time to direct my inquiries so as to give him no hint of what had been seen by Mr. WILKINS. I immediately minuted down the information he gave me, which was as follows. "Some time ago, about six in the evening, the moon "not being a quarter old, he saw a light like a star, and as "large as a middle sized star, but not so bright, in the dark "part of the moon. He continued looking at it for a minute "or more, during which time it kept the same light, and he "then lost sight of it by going into the house. He said he "thought it was not the present moon, viz. that which is now "almost gone, and that it was not above seven weeks ago. "He was not, however, certain whether it was three weeks or "seven weeks ago." I made a drawing of the moon before him, and desired him to direct me about forming the size of the crescent, and laying down the place of the star-like appearance in the dark part of the moon, which sketch I have subjoined to this account. (See Tab. XXI. fig. 3.)

Lady BOOTH thought the time of the night, when he saw this appearance, was later, and rather seven o'clock, for he mentioned it to her immediately after. Not doubting but this phænomenon, seen by THOMAS STRETTON, in St. John's Square, was the same as was seen by Mr. WILKINS at Norwich, and on the same night, I wished to ascertain the time more nearly by some local circumstances, depending on the place from which the phænomenon was seen, and the tops of the houses or chimnies over which it appeared. Accordingly, on the 21st of May, I desired THOMAS STRETTON to stand in the same place he did when he saw the appearance, and point

out to me the place of the sky where he had seen the moon, with respect to the opposite house and chimnies over which she appeared. With the help of a pocket compass and small wooden quadrant, I found the bearing of the place of the sky, which he pointed out to me, to be 80° west of the magnetic south, or 56° west of the true south meridian, and the altitude 34°. Taking the moon's right ascension from the nautical almanac for the 7th of March, the day stated by Mr. WILKINS, with the bearing abovementioned, and latitude of St. John's Square taken 51° 31′, I find the observation must have been made exactly at eight o'clock mean time, provided the bearing could be exactly depended upon; but as an uncertainty of a few degrees may be allowed therein, we may conclude that the observation was not far from eight o'clock. This agrees nearly with the time of Mr. WILKINS's observation, for he seems to have lost sight of the star on the dark part of the moon a little before eight o'clock, mean time, at Norwich, the correspondent time to which in St. John's Square, on account of the difference of meridians, would be five minutes sooner. An error only of ten minutes in the time noted by Mr. WILKINS, and that deduced from the bearing observed in St. John's Square, both taken together, will bring the observation in St. John's Square to precede the time of the disappearance of the star-like appearance at Norwich: and therefore the two observations agree as nearly together as can be expected from the circumstances in which the observers were placed, and the two observations mutually confirm each other. The altitude of the moon at eight o'clock, by computation, is 41°, or 7° higher than that taken with the quadrant; which difference may be allowed for the error such

an estimation is liable to, and affords no ground for argument against the observations belonging to the same phænomenon, and consequently is an additional confirmation of it.

In order to ascertain the time, and other circumstances relating to the phænomenon, I made some inquiries of Mr. WILKINS, by several letters, which he answered with much candour and exactness, as appears by the extracts of his answers prefixed to this account.

Mr. VINCE, in his letter to me, giving me the first notice of this phænomenon, observed that Mr. WILKINS is an eminent builder, a sensible man, and by no means likely to be deceived; and adds, that the length of time during which he saw it, seems to preclude the possibility of any deception. Mr. WILKINS himself relates that he is long sighted, and that he distinguishes very well the dark part of the moon, illuminated by a faint light, while she is young, which completes her circle. The other person, THOMAS STRETTON, is a young man of sobriety and steadiness, and long sighted also. I particularly mention these circumstances, to obviate an objection that has been made to these accounts, from the circumstance of the bright star in the south eye of the bull, called Aldebaran, having passed by the moon the same evening, and been eclipsed by the northern part of her disk. I own it is a singular coincidence of circumstances, that Aldebaran should the same evening pass behind the moon, in nearly the same track in which this star-like appearance was observed upon the dark part of the moon's disc: but the two facts, considered as independent of each other, are not incompatible. The appulse of Aldebaran to, and subsequent occultation by the moon's disc, was predicted in the nautical almanac, and observed by many.

I observed its eclipse at the moon's dark limb at $6^h\ 47'\ 30''$, and its emersion from the moon's bright limb, at $7^h\ 30^\circ\ 3''$ mean time, at Greenwich.*

The appearance of the spot of light upon the moon's dark part, and its subsequent sudden disappearance at Norwich, happened near eight o'clock; and the observation of the star upon the moon at St. John's Square happened about the same time. I would then ask the persons who make the objection, how could two persons, at two distant places, see a star appear upon the dark part of the moon, at a considerable distance within its circumference, while it was really off it, especially as they were both long sighted? and particularly, how could the immersion be observed near eight o'clock, which really happened at 54 minutes past six, or above an hour before? If it be supposed that the persons saw Aldebaran after its emersion from the moon's bright limb, that is, after half past seven, it becomes still more difficult to conceive, that a star, really on the bright side of the moon, should, by some illusion or optic fallacy, cross that bright part to appear upon the dark part; besides, this supposition does not account for the sudden disappearance of the star.

Mr. VINCE has lately informed me, that he had seen and conversed with Mr. WILKINS on the subject; who expressed himself to be certain both of the time, and place on the dark part of the moon's disc, where he saw the star-like appearance within the circumference.

* The immersion at Norwich, on account of the difference of parallax, would happen about a minute and an half later, and the emersion as much sooner; and considering also the difference of meridians, by which Norwich is five minutes of time to the east of Greenwich, the immersion at Norwich must have happened at $6^h\ 54'$, and the emersion at $7^h\ 33'$ mean time.

I shall make no conjectures on the cause to which this extraordinary phænomenon may be attributed; but only remark, that it is probably of the same nature with that of the light seen of late years in the dark part of the moon by our ingenious and indefatigable astronomer, Dr. HERSCHEL, with his powerful telescopes, and formerly by the celebrated DOMINIC CASSINI; although this has been so illustrious as to have been visible to the naked eye, and probably equal in appearance to a star of the third magnitude.

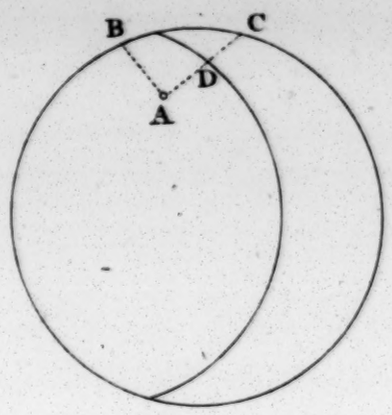


Fig. 1.

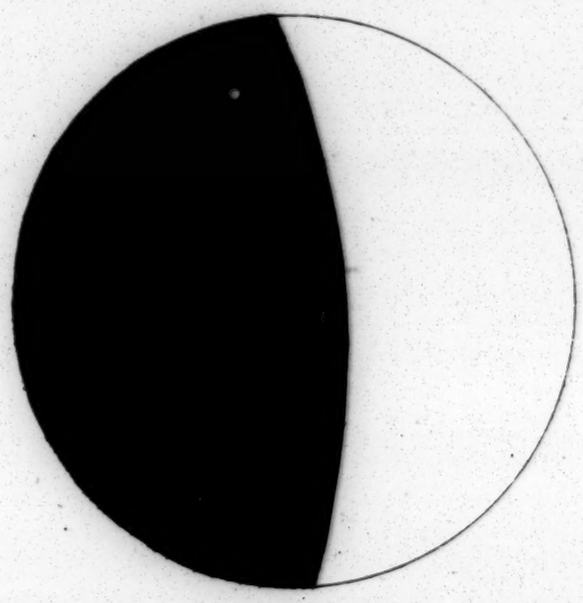


Fig. 2.

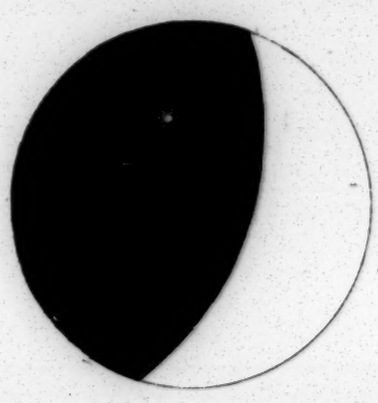


Fig. 3.

PRESENTS

RECEIVED BY THE

ROYAL SOCIETY,

From November 1793 *to July* 1794;

WITH THE

NAMES OF THE DONORS.

1793.	PRESENTS.	DONORS.
Nov. 7.	Nova Acta Academiæ Scientiarum Imperialis Petropolitanæ, Tomus VII. Petropoli, 1793. 4°	The Imperial Academy of Sciences of Petersburg.
	Commentationes Societatis Regiæ Scientiarum Gottingensis ad A. 1791 & 1792. Gottingæ, 1793. 4°	The Royal Society of Sciences at Gottingen.
	Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, Vol. XI. London, 1793. 8°	The Society for the Encouragement of Arts, Manufactures, and Commerce.
	The Morbid Anatomy of some of the most important parts of the human Body, by M. Baillie. London, 1793. 8°	Matthew Baillie, M. D. F. R. S.
	On the Determination of the Orbits of Comets, by Sir H. Englefield. London, 1793. 4°	SirHenry Englefield, Bart. F. R. S.
	Biographia Britannica, Vol. V. London, 1793. fol.	The Rev. Andrew Kippis, D. D. F. R. S.
	A Sketch of a Plan to exterminate the casual Small-Pox from Great Britain, and to introduce general Inoculation, by J. Haygarth. London, 1793. 8°	John Haygarth, M. B. F. R. S.
	A Treatise on the Structure, Economy, and Diseases of the Liver, by W. Saunders. London, 1793. 8°	William Saunders, M. D. F. R. S.
	Directions for making an universal Meridian Dial, by F. Wollaston. London, 1793. 4°	The Rev. Francis Wollaston, LL. B. F. R. S.
	Practical Observations on the Operation for the Stone, by J. Earle. London, 1793. 8°	James Earle, Esq. F. R. S.
	An Appendix to a Treatise on the Hydrocele, by J. Earle. London, 1793. 8°	
14.	Astronomical Observations made in the Voyages of Byron, Wallis, Carteret, and Cook, drawn up by W. Wales. London, 1788. 4°	The Commissioners of the Longitude.

	PRESENTS.	DONORS.
	Floræ Cantabrigiensi Supplementum tertium, auctore R. Relhan. Cantabrigiæ, 1793. 8°	The Rev. Richard Relhan, M. A. F. R. S.
	Medical Facts and Observations, Vol. IV. London, 1793. 8°	Samuel Foart Simmons, M. D. F. R. S.
21.	Descriptio et adumbratio microscopico-analytica Muscorum frondosorum novorum dubiisque vexatorum, auctore J. Hedwig, Vol. 3um. Lipsiæ, 1792. fol.	Professor Hedwig, F.R.S.
	Eclipsis Solis annularis fere centralis Varsaviæ, A. 1793, die 5 Sept. Mscr. fol. pat.	M. Bystrzycki, Astronomer to the King of Poland.
	A Treatise upon Gravel, and upon Gout, by M. Forbes. London, 1793. 8°	Mr. Murray Forbes.
	The History of Rutherglen and East-Kilbride, by D. Ure. Glasgow, 1793. 8°	The Rev. David Ure, M. A.
Dec. 12.	Codex Th. Bezæ Cantabrigiensis, Evangelia et Apostolorum Acta complectens; edidit T. Kipling. Tomi II. Cantabr. 1793. fol.	The University of Cambridge.
	J. Dickson fasciculus tertius plantarum cryptogamicarum Britanniæ. Londini, 1793. 4°	Mr. James Dickson.
	The Meteorologist's Assistant in keeping a Diary of the Weather. London, 1793. fol.	The anonymous Author.
	Annonce de la découverte d'une Science qui sert de base et de clef à toutes les autres. 4°	M. D'Eckhartshousen.
	A Sketch of a Tour on the Continent in the Years 1786 and 1787, by J. E. Smith. London. 1793, 3 Vols. 8°	James Edward Smith, M. D. F. R. S.
1794.		
Jan. 9.	Commentarii de Rebus in Scientia naturali et Medicina gestis, Volumen XXXIV. et Decadis tertiæ Index. Lipsiæ, 1792-3. 8°	Mr. Philip Hurlock, F. R. S.
	The Life of Thomas Ruddiman, by G. Chalmers. London, 1794. 8°	George Chalmers, Esq. F. R. S.
	A Meteorological Journal of the Year 1793, kept in London by W. Bent. London. 8°	Mr. W. Bent.
	A Hindoo Quadrant.	John Lloyd Williams, Esq.
Feb. 6.	Original Letters from the late Edward Wortley Montagu, Esq. containing Meteorological Observations made at Rosetta, in Egypt, in the Year 1773.	William Seward, Esq. F. R. S.
	Meteorological Journal kept at Churchill Factory in Hudson's Bay, from Sept. 6, 1792, to April 17, 1793. Mscr. fol.	———
13.	Some Considerations concerning public Roads. London, 1734. 8°	———
	El Eclipse de Sol observado en el Oceano, el 24 de Junio de 1778, par D. A. de Ulloa. Madrid, 1779. 4°	Don Antonio de Ulloa, F. R. S.
	Ephemerides Astronomicæ anni 1793, ad meridianum Mediolanensem supputatæ, ab A. de Cesaris. Mediolani, 1792. 8°	The Astronomers of Milan.
20.	Meteorological Account of the Weather at Madras, from June 1, 1787, to Dec. 31, 1790. fol. obl.	Mr. Chamier, of Vizagapatam.

	PRESENTS.	DONORS.
	A Diary of the Thermometer kept at Muglatore, in the Year 1790. 4°	Mr. Chamier, of Vizagapatam.
	Meteorological Diary kept at Maddepollam. fol. obl.	
March 6.	A Translation of the Table of chemical Nomenclature proposed by de Guyton, Lavoisier, Berthollet, and de Fourcroy. London, 1794. 4°	George Pearson, M. D. F. R. S.
20.	Historia del nuevo Mundo, escribiala D. Juan B. Muñoz, Tomo I. Madrid, 1793. 4°	Don Juan Bautista Muñoz.
	A Sermon preached at the Consecration of William Lord Bishop of St. David's, by C. P. Layard. London, 1794. 4°	The Rev. Charles Peter Layard, D.D. F. R. S.
27.	Astronomisches Jahrbuch für das jahr 1796, von J. E. Bode. Berlin, 1793, 8°	M. J. E. Bode, F. R. S.
April 3.	Collection of Engravings from ancient Vases, discovered in Sepulchres in the Kingdom of the Two Sicilies, now in the possession of Sir W. Hamilton, Vol. I. Naples, 1791. fol.	Sir William Hamilton, K. B. F. R. S.
	Theoria motus corporum solidorum seu rigidorum, auctore Leonh. Eulero. Rost. et Gryphisw. 1765. 4°	The Rev. Nevil Maskelyne, D.D. F.R.S. Astronomer Royal.
	Medical Commentaries for the Year 1793, collected by A. Duncan. Edinburgh, 1794. 8°	Andrew Duncan, M. D.
	Observations on the Disease of the Hip Joint, by E. Ford. London, 1794. 8°	Mr. Edward Ford.
	Letters on the Culture of Potatoes from the Shoots, by W. Maunsell. Dublin, 1794. 8°	The Rev. William Maunsell, LL. D.
10.	Flora Oxoniensis, auctore J. Sibthorp. Oxonii, 1794. 8°	John Sibthorp, M. D. F. R. S.
May 1.	Transactions of the Linnean Society, Vol. II. London, 1794. 4°	The Linnean Society.
	Mémoires de l'Académie Royale des Sciences et Belles Lettres, 1788 et 1789. Berlin, 1793. 4°	Comte de Hertzberg, F. R. S.
	Sammlung der Deutschen Abhandlungen, welche in der Kön. Academie der Wissenschaften zu Berlin vorgelesen worden, in den jahren 1788 und 1789. Berlin, 1793, 4°	———
	Mémoire sur le Regne de Fréderic II. Roi de Prusse, lu dans l'Assemblée publique de l'Académie des Sciences de Berlin, le 27 Janv. 1793, par le Comte de Hertzberg. 8°	———
	Discours qui a été prononcé par le Comte de Hertzberg, dans l'Assemblée publique de l'Académie des Sciences à Berlin, le 30 Janvier, 1794. 8°	———
	Relation Historique de la Statue pédestre du Roi Fréderic II. qui a été érigée à Stettin le 10 Octobre, 1793. Berlin. 8°	———
	Ueber die Bleyglasur unserer Töpferwaare, von G. A. Ebell. Hanover, 1794. 8°	Mr. G. A. Ebell.
	Historia litteraria et critica Forcipum et Vectium obstetriciorum, auctore J. Mulder. Lugd. Bat. 1794. 8°	J. Mulder, M. D.

	PRESENTS.	DONORS.
	The Construction and Use of a Thermometer for shewing the Extremes of Temperature in the Atmosphere, during the Observer's absence, by James Six. Maidstone, 1794. 8°	George May, Esq.
8.	J. Ingen-Housz Versuche mit Pflanzen, übersezt von J. A. Scherer, II. & III. Band, Wien, 1788, 1790. 8°	John Ingen-Housz, M. D. F. R. S.
	Medical Facts and Observations, Vol. V. London, 1794. 8°	Samuel Foart Simmons, M. D. F. R. S.
15.	Observations on human and on comparative Parturition, by R. Bland. London, 1794. 8°	R. Bland, M. D.
22.	A Treatise on the Conic Sections, by G. Walker. London, 1794. 4°	The Rev. G. Walker, F. R. S.
June 5.	A Sermon preached on the Fast Day, Feb. 28, 1794, by W. Parker. London. 4°	The Rev. William Parker, D. D. F. R. S.
	The Speech of the Right Hon. John Hely Hutchinson, made in the House of Commons, June 26, 1793. Dublin, 1793. 8°	William Seward, Esq. F. R. S.
	De Quadrante murali, quem speculæ Mediolanensi construxit J. Ramsden, commentarius Angeli de Cesaris. 8°	Anthony Songa, Esq.
	Effemeridi Astronomiche per l'Anno 1775, calcolate pel Meridiano di Milano, dall' Ab. A. de Cesaris. Milano, 1774. 8°	The Astronomers of Milan.
	Ephemerides Astronomicæ Annorum 1776, 1777, 1780, 1781, 1784, 1785, 1786, supputatæ Ab. A. de Cesaris. 8°	
19.	An Inquiry into the Laws of Falling Bodies, by R. Anstice. London, 1794. 8°	Mr. Robert Anstice.
	A Letter on the most effectual Means of preventing Sickness in his Majesty's Fleets, by W. Renwick. London, 1774. 8°	Mr. William Renwick.
July 3.	The Natural History of Aleppo, by A. Russell; the second Edition, enlarged by P. Russell, 2 Vols. London, 1794. 4°	Patrick Russell, M. D. F. R. S.
	Saggio della Scuola clinica nello spedale di Padova, di A. Comparetti. Padova, 1793. 8°	Professor Comparetti, of Padua.
	Riscontri Fisico-Botanici, di A. Comparetti. Padova, 1793. 8°	
10.	A Dissertation on Simple Fever, by G. Fordyce. London, 1794. 8°	George Fordyce, M. D. F. R. S.

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